



# How to get the best image for a diagnosis

Worksheet AI

Practical assignment Philips

## How to get the best image for a diagnosis

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### 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](mailto:info@lereninbrainport.nl) directly.

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## Practical info about the assignment

<b>Theme</b>	Artificial intelligence (AI), healthcare
<b>Linked subject(s)</b>	Physics, Biology, Engineering
<b>Target audience</b>	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.
<b>Final terms</b>	<ul style="list-style-type: none"><li>• Physics havo/vwo level: medical imaging</li><li>• Biology vmbo, havo/vwo level: posture and movement</li></ul>
<b>Learning goal(s)</b>	Introducing students to the challenges involved with the design of medical equipment and the possibilities that Artificial Intelligence offers.
<b>Guidance</b>	No specific knowledge required, but someone with an interest in medical imaging.
<b>Duration</b>	Separate exercises of about 1 class period each, but can be extended to a larger (cross-curricular) project.
<b>Equipment</b>	Hoe does AI help in getting a better, faster MRI-scan? <ul style="list-style-type: none"><li>• Per student<ul style="list-style-type: none"><li>○ a scan test (attached)</li><li>○ blank A4 sheet; preferably thin paper</li></ul></li><li>• Mobile phone or webcam/digital camera for taking photos</li><li>• Transparent sheets (like those for overhead projectors)</li><li>• Markers for writing on transparent sheets</li><li>• Heavy objects and modes of transport</li></ul> Second part C) Is AI better than a doctor? <ul style="list-style-type: none"><li>• List of AI arguments</li></ul>
<b>Location</b>	No requirements

## 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 enhanced 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<sup>1</sup>:

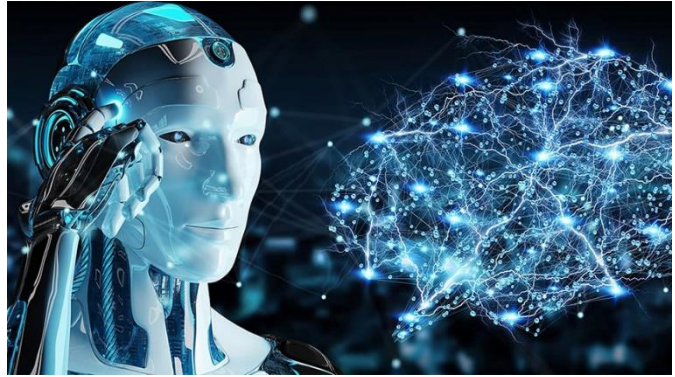


Are you in touch with a business? Ask them what challenges they face and use a similar assignment from the digital library!

## 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.



## Background information

# PHILIPS

### The company: Philips

Philips is a leading provider of healthcare technology aimed at improving people's health and achieving better care results within the entire healthcare continuum, from healthy living and prevention to diagnostics, treatment, and home care.

#### Creating innovations that matter to people

From the moment the very first Philips lightbulb was produced over 130 years ago, "innovation" and "a human-focused approach" have been important key values for Philips. Combining the two pillars "humans" and "innovation" leads to advanced technology suited to the real wants and needs of people; now and in the future.

#### Examples of products being developed by Philips

You'll see many of Philips' solutions in hospitals, such as life support equipment for intensive care units and monitoring equipment for premature babies. And also MRI systems. An MRI scanner uses radio waves and a very strong magnetic field to create an image of what's going on inside the body. An MRI investigation basically allows you to look at a patient from the inside to see if anything's wrong and if so, what – in other words, diagnose them. Philips also develops "care environments" where patients and staff feel more at ease, and which improve patient experience and satisfaction - such as the Ambient Experience.



*Patients feel more comfortable and at ease in the Ambient Experience, making it easier for them to lie still during an examination.*

## The project: AI for quicker and better MRIs and diagnoses

According to Philips researchers, Artificial Intelligence is hugely promising for the imaging world. An MRI scan currently easily takes up 15 minutes to half an hour. If we can reduce that time to just a few minutes, it would be a gain for both patient and practitioner. Using AI in the image processing of an MRI scan creates clearer images, but also allows you to get a clearer image with less data (and thus less time).



AI is also used to interpret MRI scans: the software learns from specialised physicians how to reach a diagnosis. This "decision tree" forms the basis of the software. That is not as easy as it sounds. To get it to reach a good diagnosis, the physician feeds it many different MRI scan images with the accompanying diagnoses. This means the AI's algorithm is only as good as the information it gets. Since an MRI scan can be so important to a patient's health, it's imperative that these machines don't make any mistakes. How do you guarantee that?

Check this video about AI and healthcare from the National AI Course<sup>ii</sup>



## The assignment: How to get the best image for a good diagnosis

Students use examples and an exercise to learn how to improve an image by using AI. They also look at how this technique can reduce the time someone has to spend inside an MRI scanner.

Next, they learn how you can train AI to recognise images and how to use this to reach a diagnosis based on an MRI scan.

## The class

### Introduction by teacher

- If possible, create a link to previous lessons.
- Show the following video on the topic: "How does AI improve healthcare?"<sup>iiii</sup>
- If needed, tell the students more about Philips, MRI scanners, Artificial Intelligence and the connection between the latter; see background information.
- Explain the overall structure of the assignment.



### Execution

The assignments consist of several smaller exercises. These all go together, but can also be done separately. For a full assignment you complete all exercises. Sometimes they contain duplicate subjects, which you can then skip. You can also do one part of assignment one, "How does AI help to create a better MRI scan faster?" and one part of assignment two, "How does AI help with diagnosis?"

You choose your assignment based on the time you have and what the main area of focus is for your students.

### How does AI help to create a better MRI scan faster?

An MRI scan currently takes around 15 to 30 minutes. During this scan, the patient has to lie as still as possible to get a clear image. That's a long time.

**A) Why does an MRI scan take so long?**

Students learn that a fast scan is less accurate and that AI can help improve the scan's image.

**B) How can you scan faster?**

Using photos taken by their mobile phones, students see that AI can improve the image, and they think about the pros and cons of a fast MRI scan using AI.

**C) How does AI learn how to create a good image from a quick scan?**

Students experience how an AI system learns, using simple online AI exercises. They then extrapolate this to AI learning with an MRI scanner.

**D) AI for quicker MRI scanning... What do you think?**

Students dive deeper into the pros and cons of AI for quicker scanning, followed by a class debate based on those pros and cons.



## How does AI help in diagnosis?

### A) What does AI "see"?

Students use apps on their smartphone to learn how an AI system recognises images. They examine an MRI scan of their own.

### B) How does AI know what it sees?

Students train a simple online AI system to recognise things. Based on this exercise they will come up with ways to teach an AI system to recognise anomalies on an MRI scan.

### C) Is AI better than a doctor?

Students look at the pros and cons of AI in diagnosis. Using those pros and cons they will discuss how to inform patients and hospitals about AI in healthcare.

## At-home assignment

This assignment requires no other material than the student material; possibly a printer and a computer connected to the internet.

## Evaluation

To discuss with students:

- What did they find interesting about the practical assignment?
- How would they potentially need the methods from this assignment in their future profession?
- What do the students find interesting about ...:
  - Philips
  - AI
  - Medical imaging and MRI
  - Engineering in medicine
- Which topics from the book do they see reflected in this assignment?  
So why do they learn that?

## Tips for the teacher

### How does AI help to create a better scan faster?

An MRI scan currently takes around 15 to 30 minutes. During this scan, the patient has to lie as still as possible to get a clear image. That's a long time.

#### A) Why does an MRI scan take so long?

1. Are students having trouble seeing the scan test lines through the paper?  
They can hold the sheets against a window, making it easier to count the lines.
2. Expensive scanner with AI: for specialists, in hospitals where MRI scanners are constantly booked up, for children, for simple scans, in university hospitals  
Cheaper scanner without AI: in regional hospitals, private clinics, global scan, for adult patients without claustrophobia, etc.

#### B) How can you scan faster?

1. The quality of mobile phone cameras can vary a lot. If needed, check beforehand whether at least one of the students has a model of at least three years old and one student has the latest model.

#### C) How does AI learn how to create a good image from a quick scan?

1. Examples of different circumstances: wearing something of the same colour as the background / very low lighting / if there's two people in front of the camera, etc.

#### D) AI for quicker MRI scanning... What do you think?

1. Possible answers: using a standard scan if you want to find small anomalies that may have been filtered out in an AI scan, or having a very fearful child.  
The answers don't have to be right, but they need to be plausible.
2. Yes: University hospitals or highly specialised hospitals in large cities / rich countries / paediatric hospitals ...  
No: Private clinics / regional hospitals / hospitals in poorer countries ...

### How does AI help in diagnosis?

#### A) What does AI "see"?

1. Please note: use the apps that the students already have wherever possible.  
Wombo.ai seems to handle data and images quite decently, but Snapchat definitely does not.

#### B) Is AI better than a doctor?

1. You can choose to have a debate with this exercise as well. Let the students come up with a statement for this themselves.

## Broadening the subject

### Together with businesses

- This assignment can be easily linked to other educational material for Philips. One example is the practical assignment of the Humans and Health World from the 7 Engineering Worlds Expedition by Jet-Net & TechNet (currently only available in Dutch). This assignment is about making an MRI scan a more child-friendly experience.  
(Go to <https://www.jet-net.nl/expeditie> and sign up)
- There are other companies besides Philips that work with AI for healthcare, for example a hospital. You could ask radiologists how creating an MRI scan works and what their views are on the potential of AI.

### A cross-curricular assignment with...

- **Biology**  
What happens in the body when we get ill? What changes in the tissues? Which imaging methods are there? When do you use MRI or not? What does this do to the patient?
- **Physics**  
Goes with medical imaging techniques
- **Social Studies / Philosophy**
  - What would it do to people if everything were diagnosable? How would society look if imaging methods were to become very cheap and accessible?
  - Say AI becomes mainstream. Would doctors, after years of relying on AI, still be able to diagnose on their own?
  - Some people will get themselves scanned in a commercial clinic once a year, "just in case". But many "anomalies" on a scan turn out to have no adverse health effects at all. Would you do that?
- **Economics**  
What would it mean for the economy if cheap and accessible methods prevent illness quicker and thus make them more treatable?
- **Modern Foreign Languages**  
Philips experts are from all over the world, and they work with people from all over the world as well. What would be their language of communication? Why? What are the barriers or challenges? Think about things like cultural differences, language barrier, technical jargon, differences in education, etc.

### For students from a non-Dutch background

- For business activities: perhaps the department 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...

AI: The National AI course<sup>iv</sup>



AI in healthcare<sup>v</sup>



Deep learning in healthcare  
*How long before we'll accept a digital doctor?*<sup>vi</sup>



Philips<sup>vii</sup>



Philips, AI and MRI<sup>viii</sup>



Other AI projects by Philips<sup>ix</sup>



## Student assignments

### Hoe does AI help to create a better MRI scan faster?

Patients get an MRI (Magnetic Resonance Imaging) scan if for example a doctor needs information about the brains, muscles or tendons. An MRI scan takes about 15 minutes to half an hour. It's also important for the patient to lie as still as possible in order to get a clear image, which can be difficult for adults, let alone children.

Watch this educational video for children about doing an MRI scan<sup>x</sup>:

In 2020 Philips in Eindhoven was one of the winners in a contest aimed at speeding up the time it takes to do an MRI scan using Artificial Intelligence.



With new AI algorithms they can scan patients faster and still deliver good diagnostic images:



Standard scan: 4 min



10x faster: 24 seconds



10x faster: 24 seconds  
WITH AI!

Watch a short explanation about this contest here<sup>xi</sup>:



With new AI algorithms they can scan patients faster and still deliver good diagnostic images.

AI does this by "guessing" what the image should be.

## A) Why does an MRI scan take so long?

An MRI scan takes around 15 to 30 minutes. During this scan (full of loud banging and ticking noises) patients have to remain completely still. This is a very long time for children or for claustrophobic patients. There's a big chance they'll still move during the scan. If that happens, the scan will have to be taken again.

In this assignment you'll learn why an MRI scan takes this long.

Ask your teacher for:

- the "scan test"
- a blank sheet of paper
- a timer

How long does it take you to trace the image on the scan test?

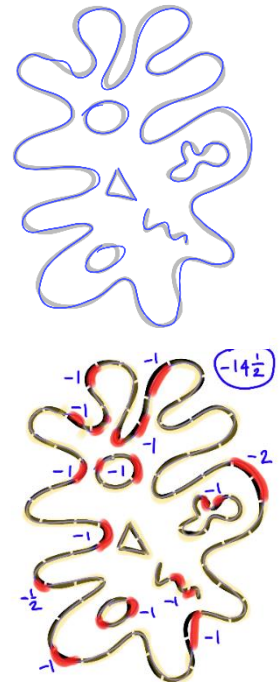
1. Trace the image on the scan test with a pen or thin marker. Measure how long this takes you. Fill in your time in the table under exercise 4.

How accurate was your drawing?

2. Ask your teacher for the "scan test check". Calculate your accuracy score: how much percent of the drawing was inside the lines? Fill in your accuracy score in the table under exercise 4.

How accurate are you if you work faster?

3. Take a new sheet of paper. Trace the lines of the image again, but this time do it **within 10 seconds**.
4. Calculate your accuracy score again. Fill in your score in the table below.



Drawing time	Accuracy score or number of incorrect lines
_____ seconds	_____ %
10 seconds	_____ %

5. What is the link between the drawing (i.e. scanning) speed and the accuracy of your drawing?

If you scan *faster/slower*, the accuracy gets \_\_\_\_\_.

6. This link also applies to an MRI scan. Researchers are working on ways to scan faster regardless. In your own words, explain why a clear scan is important, but a fast scan is important too:

An MRI scan image has to be clear enough, because...

The advantage of a fast scan is that...

So it's important that the image in an MRI scan is clear enough to be able to reach a diagnosis. At the moment this requires a scan of about half an hour. But the less time it can take, the better!

The MRI scanners being developed by Philips are becoming faster - partly by improving the machine and partly by developing better image processing software.

Among other things, Philips uses Artificial Intelligence (AI) to get better quality images quicker. To do this, the software calculates what the image should look like.



Standard scan: 4 min



10x faster: 24 seconds



10x faster: 24 seconds  
WITH AI

7. Look at the images of a knee MRI on the previous page. One difference is already listed in the table below. Note at least three more differences between the standard scan and the AI scan.

Difference	Standard scan: 4 min	10x faster: 24 seconds WITH AI
Edges	Sharp	Blurrier

8. Name two advantages of doing an MRI scan with AI.

The advantage of a quick scan with AI is...

9. Name two disadvantages of doing an MRI scan with AI.

The risk of a quick scan with AI is...



Below are more pros and cons of an MRI scan with AI:

	Standard scan: 4 min	10x faster: 24 seconds WITH AI
Image quality	Original	Calculated
Scan duration	Long	Short
Costs per scan	Lower	Much higher

So, using AI means an MRI scan can be done much quicker. But the machines that have that capability are still very expensive.

10. Describe when a doctor would want to use an expensive MRI scanner *with* AI and when they would want to use a cheaper scanner without AI.

You would use an expensive MRI scanner with AI when...

You would use a cheaper MRI scanner without AI when...

## B) How does the quicker scan work?

The technology Philips uses to be able to scan quicker, is comparable to the one you use to enhance photos on your phone or to blur the background.

In this exercise you'll learn which improvements are possible using this technology.

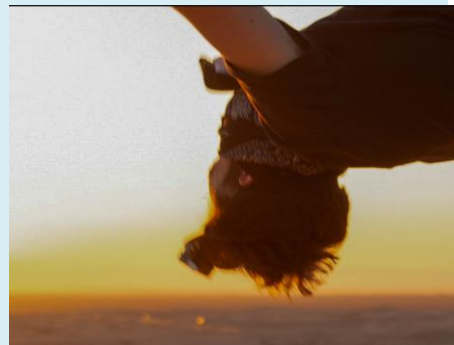
1. Form groups in class. Make sure that there is at least one person in each group with a brand-new smartphone and one person with an older mobile phone (that can still take pictures).
2. Have both of them take a picture of the same object. Take a "difficult" picture, for example in a dark corner or in front of the window.
3. Compare both photos. Try and find as many differences as you can. Also note the differences when you zoom in, for example.

Fill out the table below with as many differences between the pictures as you can find.

	Old model	New model	...
	model:	model:	
File size	MB	MB	MB

One reason why pictures on newer mobile phones are better is because new phones have better lenses. They catch more light, making the image better. But the software on your phone makes a big difference too. If your phone were to save all the information from a picture (like professional photo cameras do!), you could edit the picture in a lot of ways. Most people don't want to do that, so the software on your phone edits it for you and then deletes the information that's no longer needed.

Compare the two pictures below: you can see a difference, but the one on the right is decent too and takes up a lot less memory!



Edited from .RAW

.JPG

Size 22 MB

7 MB

In exercise 3 you compared pictures. Newer phones have better programmes to calculate what to do with the image to make it look nicer.

4. What does a newer phone do better than an older one? How can you tell from the pictures?

New phone is better in at...	You can tell from...

Current MRI scans are comparable to the picture on the left. But for a good diagnosis, the picture on the right is often (not always!) enough.

If you know beforehand which information to leave out, you can scan much quicker. The software then figures out how to calculate how the picture was supposed to look: a much quicker scan with (almost) the same result!

The AI program that calculates the scans needs to be trained first. This is done by feeding it lots of scans: raw standard scans and raw fast scans. Based on that database, the program will learn to reconstruct the sharp image from the fast (and blurry) scan. As we like to say: an AI program is as good as the data it gets fed!

Below are the pros and cons of an MRI scan with AI:

	<b>Standard scan: 4 min</b>	<b>10x faster: 24 seconds WITH AI!</b>
Image quality	Original	Calculated
Scan duration	Long	Short
Costs per scan	Lower	Much higher

So, AI ensures that an MRI scan can be done much quicker. But the machines with this software are still very expensive.

5. Describe when a doctor would want to use an expensive MRI scanner with AI and when they would want to use a cheaper scanner without AI.

You would use an expensive MRI scanner with AI when...

You would use a cheaper MRI scanner without AI when...

## Extra challenge

Are you good at editing pictures? Then follow the steps below:

- Take your own .raw picture or download one from this website: <https://www.signatureedits.com/free-raw-photos/>
- Convert it to different file formats like .jpeg, .png, .bmp, etc. You can do this on <https://cloudconvert.com/raw-converter>, but you can also use your own software if you have it.
- Open the pictures in photo editing software (can also be done online). Zoom in on the same area in each picture.
- Note as many differences as you can. Fill in the "Differences" table and add to it.
- Watch how each picture reacts to the same edits:

Differences: picture edits				
	.bmp	.png	.jpeg	.raw
No edits				
Pixel size				
Contrast				
...				
Edit: adjusting brightness				
Edit: ...				

### C) How does AI learn how to create a good image from a quick scan?

By applying Artificial Intelligence to MRI scans, the image of fast (and thus raw) scans can be converted into a much better one. But how does AI learn what each specific area on the MRI scan is supposed to look like?

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

1. Examine how the AI program Autodraw learns:
  - Open the website <https://www.autodraw.com/>
  - In the left menu, select the pencil with the stars around it
  - Draw a shape (any shape!)
  - At the top of your screen, you'll see: "Do you mean..."
  - Click on the first icon after it. Was that what you meant to draw?
  
2. Draw your drawing again below. What did Autodraw think it was?



Drawing:	Autodraw thought:

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.

3. Which elements in your drawing make Autodraw choose that icon?  
Give these essential elements a colour in the drawing you made above.

An MRI scan with AI technology allows you to make a quick scan. The machine captures a lot less image (less data) in less time than a regular MRI scan would. This means the image quality becomes much worse. The missing data is then “calculated” by a specially developed AI algorithm, to create a complete and detailed image:



Standard scan: 4 min

10x faster: 24 seconds

10x faster: 24 seconds  
WITH AI!

4.

5. How could you train an MRI system to make a quick scan clearer (sharper)?  
(Think about the Autodraw AI exercise!)

To make a scan clearer, it needs to know this:

You can train it by:

A "trained" program keeps learning every day. Compare it to how Microsoft Teams, Zoom or Google Meet work, where you can set a background filter (or change the background), or a similar function on a mobile phone.



Original



With background filter

6. Describe in which conditions a filter best removes the background. Which conditions are still difficult for the filters?

The background filter in Teams works best if:

But not quite as well with:

These background filters work based on AI: it thinks of where "a person" sits (try it with an animal or a doll!) and then decides what is background that can be removed.

The AI software in an MRI scanner works in a similar way: it decides which part of the image should be "white", for example, and which part a certain shade of grey. This means an MRI scanner with AI has the same limitations as a camera on your mobile phone.

7. Describe in which conditions an MRI scan with Artificial Intelligence could work well. And when would it not work so well?

An MRI scan is good at calculating with AI if:

But not quite as good if:



## D) AI for quicker MRI scanning... What do you think?

Artificial Intelligence can speed up MRI scans by calculating and extrapolating what the image should be. An MRI scan with AI technology allows for a shorter scan duration. The machine captures a lot less data and thus less of the image than a regular MRI scan would. This means the image quality becomes much worse. The missing data is "calculated" by a specially developed AI algorithm, to create a complete and detailed image:



Standard scan: 4 min



10x faster: 24 seconds



10x faster: 24 seconds  
WITH AI

In this exercise you form an opinion on the use of Artificial Intelligence (AI) in MRI scans.

1. Who benefits from making MRI scans quicker?

2. The image on the previous page shows the results that Philips achieved with the Fast MRI Challenge.

When would you use the standard scan? When would you use the quick AI scan?  
Why?

Standard scan if:

Quick scan if:

Because...

The AI program that calculates the scans needs to be trained first. This is done by feeding it lots of scans: standard scans and raw fast scans. Based on that database, the program will learn to reconstruct the sharp image from the fast (and blurry) scan. As we like to say: an AI program is as good as the data it gets fed!

3. What does this development mean for the role of the doctor?  
Which advantages or disadvantages would they experience?

Advantages:	Disadvantages:
Because...	

Developing and training an AI program takes a lot of time. This means that the machines that are able to use AI for an MRI scan are still very expensive.

4. Which hospitals would purchase an AI MRI scanner? Which ones wouldn't?

Would purchase:	Wouldn't purchase:
Because...	

5. Have a class debate on the following statement:

**The government should make it mandatory for all hospitals to only use quick MRI scans with AI technology.**

Use the considerations from previous exercises.

## Exercises for students

### How does AI help in diagnosis?

Doctors perform an MRI scan on patients when they need more information about tissue and muscles. For example, if there's fluid in your knee, if you have a backache and they need to figure out the cause, and so on.

The doctor will study the MRI scan and check for "anomalies": what does a healthy knee look like? How does it look on the scan? What could have caused that difference? Often, the doctor will not only base their diagnosis on the MRI scan but instead combine the results of the scan with other exams to reach a diagnosis.

But doctors look at a lot of scans every day and have to evaluate each of them. You can perhaps imagine that this is more difficult at the end of a day than when they start "fresh" in the morning.

On top of that, a doctor only has their own knowledge; how great would it be if each doctor could use the knowledge of the best MRI specialists in the world?

In Best, the Netherlands, Philips develops MRI systems that use Artificial Intelligence (AI) to make autonomous diagnoses. This could be a huge help for doctors in their daily jobs!

To be able to diagnose, the system has to be capable of the following:

- Knowing where different areas are
- Knowing which parts they are
- Knowing if that matches a healthy image or a specific disease, and vice versa

## A) What does AI "see"?

In order to reach a diagnosis, the AI system has to at least know which "spot" on the scan means what.

In this exercise, we'll see how an AI system can learn where certain parts are.

1. Form groups in class in which at least one student has one of the following apps on their phone:
  - Wombo.ai
  - Snapchat
  - A photo program that can "tag" (recognise) people
2. Use the app to take a picture or video and let the program do "its thing".

All three of these programmes can recognise where faces are and sometimes even whose faces they are.

3. Try and think of as many things the app has to be capable of in order to do this, and write them down below.

To recognise a face, the app has to be able to do the following things:

There are more and more programs these days that can "recognise" things: faces (like with the apps), the difference between a pedestrian and a tree in the case of self-driving cars, or in the case of an MRI scan, the disease.

Before a program recognises an object, it first has to know that there is in fact an object.

4. In the picture opposite, draw which "fields" the program you used in exercise 1 has to recognise.
5. Give each field you marked a "label" (for example, nose, etc.)



A computer program can only measure (i.e. "see") things you can put a label on. These are "characteristics", such as colour, distance, place and so on.

Look at the image below. This is an MRI scan of a heart. Which characteristics could a program pick out?

6. Describe these characteristics and draw them in the image.

Characteristics that can be picked out in the image:



The next step is for the program to recognise what the characteristics stand for. For example: where is the ribcage? What is the heart? What is a vessel? Etc.

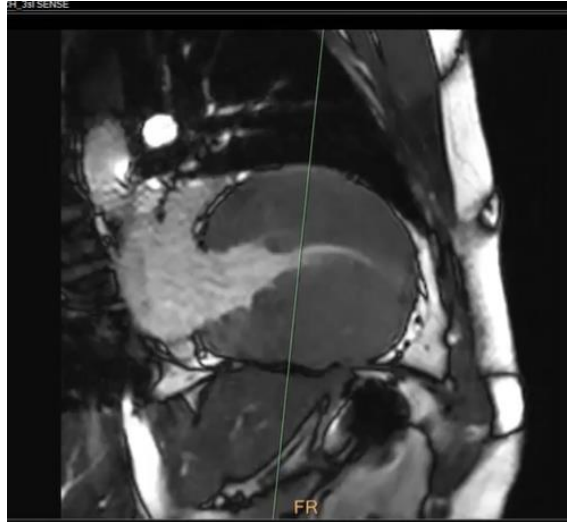
7. Visit the following website:

<https://www.mriclinicalcasemap.philips.com/global/case/36/i>.

Click on the image above "Easy cardiac viewing". You now see a video MRI of a beating heart. Look closely at the video and decide where the heart and ribcage would be and what could be a blood vessel.



8. In the image below, name as many of the areas as possible. Use the information from the video and Binas T84C. Name at least the heart, the ribcage and an artery.



Now you've seen how Artificial Intelligence can look for characteristics in an image or video and "label" them. You've also seen that you can do this with MRI scans. This means you can use Artificial Intelligence to diagnose patients.

9. Describe how you can use these Artificial Intelligence qualities to diagnose based on an MRI scan:

To diagnose, you need to be able to:

AI can...

So it can diagnose by...

## B) How does Artificial Intelligence know *what it sees*?

In order to diagnose, an AI system has to be able to interpret the spots and patterns on an MRI scan to recognise whether this is a healthy or an abnormal image – and if it is abnormal, which disease this anomaly corresponds with.

In this exercise, we'll see how an AI system can learn what those parts on a scan mean for a patient. The system has to be able to see the following:

Is there an anomaly in the scan? Is this someone with disease A or B?

By just looking at this scan here you won't know whether it shows an anomaly or not. You have to be taught.



AI can be taught these things, too. In the next exercises, you will be teaching an AI program to do things on its own.

1. Visit the website <https://donottouchyourface.com/>.  
Teach the program when you are NOT touching your face and when you ARE touching your face. The program will tell you how.
2. Now test how well the program recognises whether or not you're touching your face: when did it get it right? And when did it not?
3. Describe below how the program has learned to warn you.



The program "Donnottouchyourface" is able to recognise when I'm touching my face because:

4. Visit this 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!
- Draw the exercise given by the program six times. Is the program able to guess what you're drawing?
- Choose one of the drawings. Google now shows you how it learned to recognise your drawing!

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

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



You've now seen how you can teach AI: by giving lots of examples that AI can replicate.

6. How could you train an AI system to recognise anomalies on an MRI scan that correspond to certain diseases?

In order to train an AI system to reach diagnosis, you need to...

### C) Is AI better than a doctor?

Artificial Intelligence can play an important part in supporting doctors in their diagnostics. In the future, AI systems may even be better at it than doctors! But not everyone has the same level of confidence in a computer that diagnoses diseases.

In this exercise we will look at the pros and cons of Artificial Intelligence in diagnosing.

1. Ask your teacher for the "List of AI arguments".
2. Watch the video "The world of AI - AI and healthcare" by the National AI Course up until 2:10 minutes<sup>xii</sup> (the video is in Dutch, but you can add English subtitles).



Use the list of AI arguments to write down as many arguments that people in the video give for or against the use of AI in hospitals.

3. Artificial Intelligence extrapolates scans and data from doctors, predicts what the image could look like and uses that information to give a diagnosis. Exactly *how* AI does that (the underlying algorithm) can't be traced.  
Use the list of AI arguments to write down the pros and cons of this learning method by AI: How does this improve the diagnosis? But what do you need to watch out for?
4. Not all doctors are excited to use AI for diagnosis.  
Watch the rest of the video "The world of AI - AI and healthcare" by the National AI Course from exercise 2 (from 2:10 minutes onwards).  
Use the list of AI arguments to write down why doctors do or don't let a computer help them diagnose.
5. The newer the development, the more expensive the machines are at first. This also goes for MRI scanners with the newest AI systems. On the other hand, a faster MRI scanner that can diagnose can also ensure that more patients can be scanned. And that will in turn mean profits.  
Use the list of AI arguments to write down why a hospital would or wouldn't want to invest in an MRI scanner with AI. For which hospitals would this be interesting? And for which wouldn't it be?
6. Think of and write down more arguments of your own in support of or against AI in healthcare.
7. Write a plan from a hospital's perspective about whether you would inform people that their diagnosis is made by Artificial Intelligence and how you would do that.

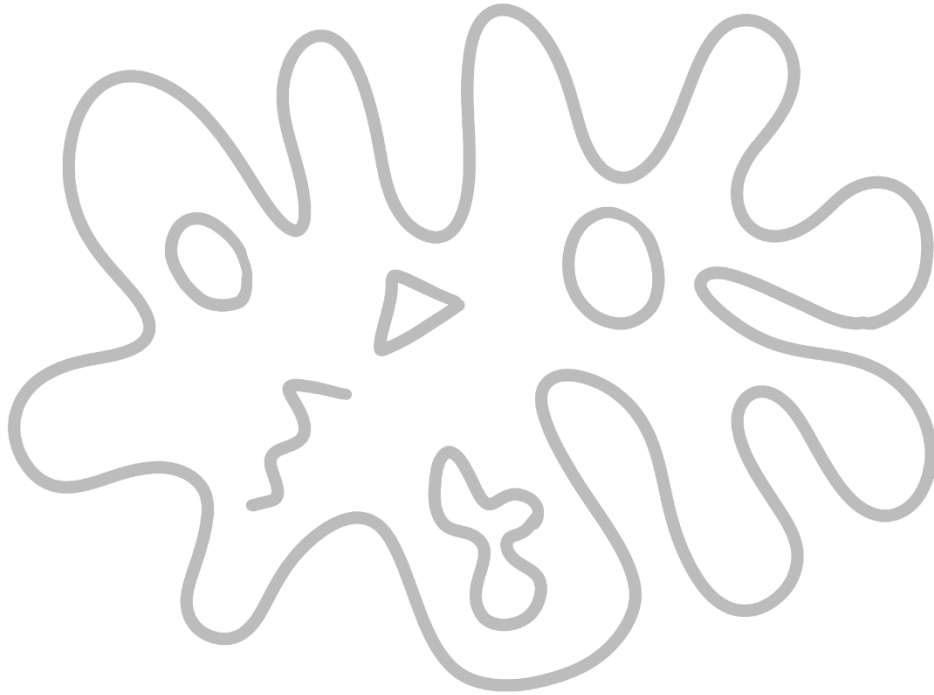
OR

8. Write a plan from Philips' perspective about how to inform hospitals to choose an MRI scanner with Artificial Intelligence.

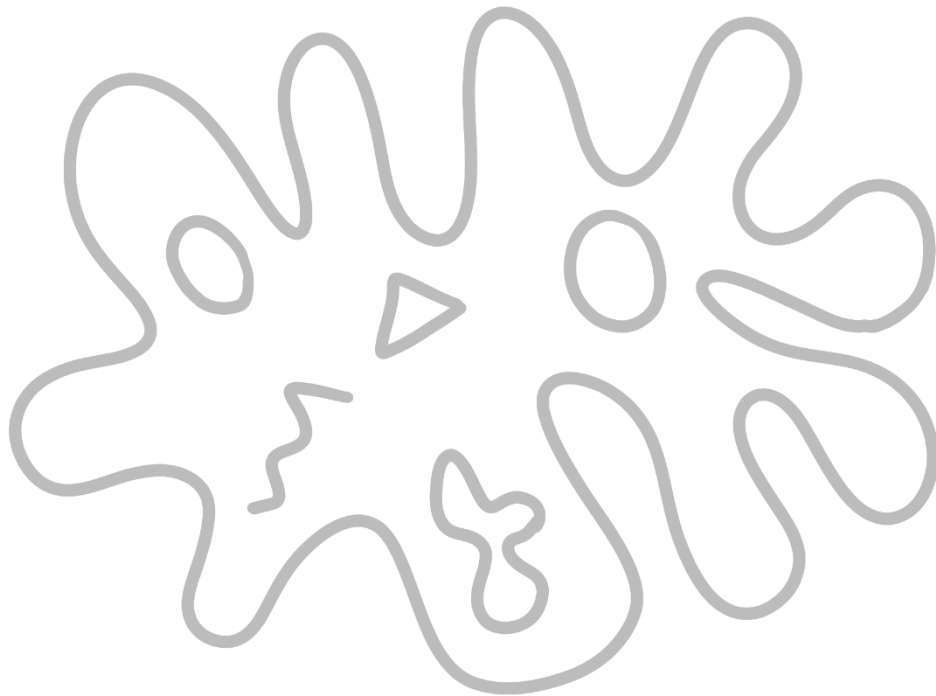
## Attachments

### Scan test

1. Measure how long it takes you to neatly trace this image.

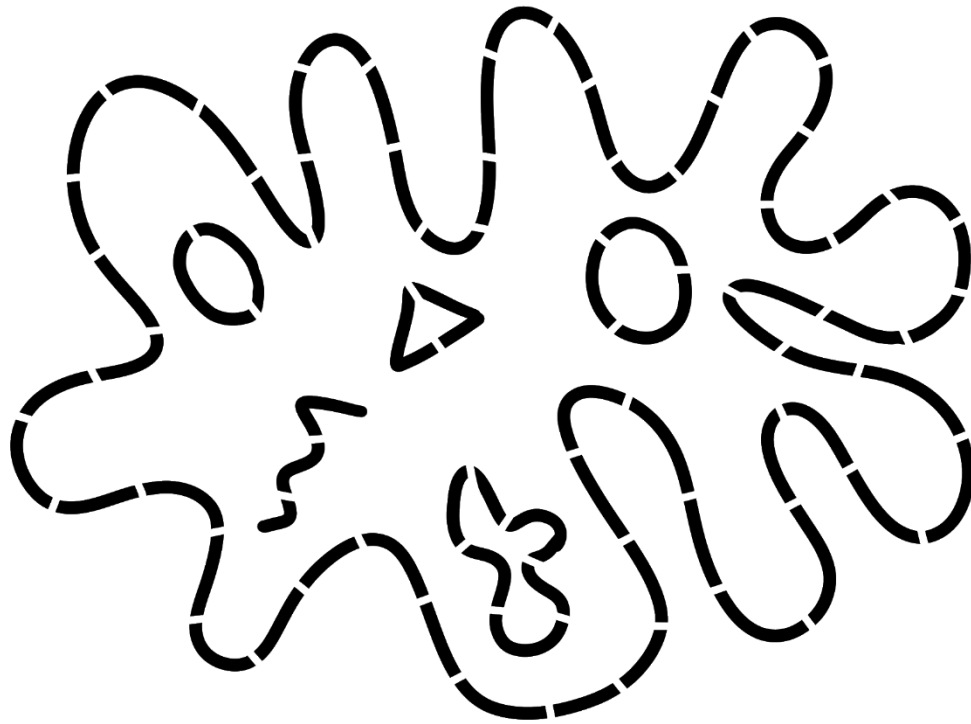


2. Use the scan test check to calculate your accuracy score: how much of the line is inside of the grey line?
3. Trace the image again, but this time within 10 seconds.

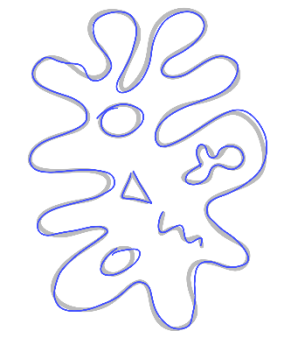

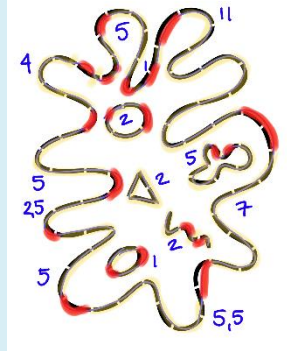


4. Calculate your accuracy score again.

## Scan test CHECK



Calculate your accuracy score:

Check your drawing	Mark the parts that fall within the grey line (yellow here) and outside of the grey line (red here)	Place your drawing on top of the image above and count how many lines you got right (yellow here)
		

Calculate your accuracy score (ACC) as a percentage:

$$ACC \text{ score} = \frac{(\text{number of correct lines})}{(\text{total number of lines})} \times 100\%$$

The entire image contains 68 lines. In the example above, the score would be as follows:

$$ACC \text{ score} = \frac{58}{68} \times 100\% = 85\%$$

### List of AI arguments






It is safer for patients to be diagnosed by AI than by doctors?

Yes, because...	No, because...

## 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 study programs at every level of education.

Looking for a specific AI degree program? Check your options in the table below.

Institute	Program or course	
Summa College	<b>Elective program Minor Embrace TEC</b> A broader elective program centred on Technology, Entrepreneurship and Creativity. This also features AI. <sup>1</sup>	
Summa College	<i>Software developer, mbo (vocational education) 4<sup>2</sup></i>	
Summa College	<i>Mechatronics mechanic, mbo (vocational education) 4<sup>3</sup></i>	
Summa College	<i>Smart Industry Technician, mbo (vocational education) 4<sup>4</sup></i>	
Summa College	<i>Automotive engineering technician, mbo (vocational education) 4<sup>5</sup></i>	







<sup>1</sup><https://www.summacollege.nl/updates/detail/2021/01/06/wil-jij-de-vaardigheden-van-morgen-leren-kies-embrace-tec>

<sup>2</sup>[https://www.summacollege.nl/opleidingen/opleidingen-overzicht/opleiding-detail/software-developer-\(bol\)](https://www.summacollege.nl/opleidingen/opleidingen-overzicht/opleiding-detail/software-developer-(bol))

<sup>3</sup>[https://www.summacollege.nl/opleidingen/opleidingen-overzicht/opleiding-detail/technicus-mechatronica-\(bol\)](https://www.summacollege.nl/opleidingen/opleidingen-overzicht/opleiding-detail/technicus-mechatronica-(bol))

<sup>4</sup>[https://www.summacollege.nl/opleidingen/opleidingen-overzicht/opleiding-detail/technicus-smart-industry-\(bbl\)](https://www.summacollege.nl/opleidingen/opleidingen-overzicht/opleiding-detail/technicus-smart-industry-(bbl))

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

Institution	Program or course	
ROC Ter AA	<i>Software developer, mbo (vocational education) 4<sup>6</sup></i>	
ROC Ter AA	<i>Mechatronics mechanic, mbo (vocational education) 4<sup>7</sup></i>	
Fontys	<b>Degree programs<sup>8</sup>:</b> Bachelor ICT Applied Mathematics Logistics Engineering	
Fontys	<b>Minor Embrace TEC</b> A broader elective program centred on Technology, Entrepreneurship and Creativity. This also features AI. <sup>9</sup>	
TU/e	<b>Degree programs:</b> Bachelor Data Science <sup>10</sup> Master Data Science and Artificial Intelligence Master Data Science and Entrepreneurship	
TU/e	<b>Face the challenge @ Innovation Space<sup>11</sup></b> 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	

<sup>6</sup> <https://roc-teraa.nl/opleidingen/software-developer/>





<sup>7</sup> <https://roc-teraa.nl/opleidingen/monteur-mechatronica/>

<sup>8</sup> <https://fontys.nl/Over-Fontys/Artificial-Intelligence.htm>

<sup>9</sup> <https://fontys.nl/Studeren/Minoren/Embrace-Technology-Entrepreneurship-Creativity.htm>

<sup>10</sup> <https://www.tue.nl/studeren/bachelor-college/bachelor-data-science>

<sup>11</sup> <https://studiegids.tue.nl/verbreding/innovation-space/>

Institution	Program or course	
TU/e	<p><b>SerpentineAI student association<sup>12</sup></b></p> <p>Would like a little extra with your TU/e studies? Join the SerpentineAI student association!</p> <p>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.</p>	
TU/e	<p><b>Fruitpunch AI student association<sup>13</sup></b></p> <p><i>Learn how to apply AI by solving real-world challenges</i></p> <p>We apply AI for Good in projects like: <a href="#">AI for Wildlife</a>, where we're building an autonomous drone that hunts down poachers in the wildlife reserves of South Africa, <a href="#">AI for Health</a> where we're applying AI to assist doctors in diagnosis and prevent the suffering of millions of people and <a href="#">AI for Food</a>, where we're developing robots that make it so we can feed more people, while using less farm ground.</p>	
TU/e	<p><b>Tech United student association<sup>14</sup></b></p> <p>Tech United is a multidisciplinary team of students, alumni, PhDs and employees from Eindhoven University of Technology that engage in the development of robotics. Knowledge in the fields of mechanical engineering, electrical engineering and computer algorithms is used to solve problems.</p>	
TU/e	<p><b>Blue Jay student association<sup>15</sup></b></p> <p>Drones have the power to extend our senses and actions. The real potential of drones is still subject to experimentation and exploration. 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.</p>	

<sup>12</sup> <https://serpentine.ai/>

<sup>13</sup> <https://fruitpunch.ai/>

<sup>14</sup> <https://www.techunited.nl/>

<sup>15</sup> <https://www.bluejayeindhoven.nl/>



## Links used in QR codes

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- i <https://www.instagram.com/brainporteindhoven/guide/ai-artificial-intelligence/17939865835446145/>
- ii <https://youtu.be/QgcZ0vGh1c4>
- iii <https://www.youtube.com/watch?v=QgcZ0vGh1c4>
- iv <https://app.ai-cursus.nl/home>
- v <https://www.philips.nl/a-w/about/news/archive/standard/about/news/articles/2020/20201209-de-toekomst-van-gezondheidszorg-is-made-in-040.html>
- vi <https://www.youtube.com/watch?v=btOBYDMqL5M>
- vii <https://www.philips.nl/healthcare/>
- viii <https://www.philips.com/a-w/about/news/archive/standard/news/articles/2019/20190510-philips-highlights-growing-role-of-ai-in-mr-at-ismrm-2019.html>
- ix <https://www.philips.com/a-w/about/artificial-intelligence/ai-enabled-solutions.html> AI enabled solutions
- x <https://youtu.be/3GLo2neGbtQ>
- xi <https://www.youtube.com/watch?v=b7ry2HgkDpY>
- xii <https://youtu.be/QgcZ0vGh1c4?t=77>