Project name	Bridges and Quay Walls Maintenance by analyzing the data from Weigh-In-Motion and Camera Systems
Description	The city of Amsterdam expects the need to strengthen many bridges and quay walls when current traffic load standards are applied for assessing these structures. We want to measure the weight spectrum of actual city traffic to investigate if a reduction of the loads with which these structures need to be assessed is viable and thus a reduction in the amount of structures that will need (immediate) strengthening can be achieved. This will help the city of Amsterdam to organize the maintenance challenge it now faces and to improve the accessibility of the city during the period of maintenance. Within this research project, we apply two [redacted] systems to measure the weights of passing vehicles; the strain on the bridge that these vehicles cross and a camera system to gather images of the vehicles and the actual traffic situations. These systems gather enormous amounts of data that need to be analyzed and for which AI can be used to achieve our goals. We have identified the following challenges that may be solved with AI: ***Determining the amount of axles*** Images of passing vehicles need to be analyzed by hand if we want to further determine and improve the reliability of the [redacted] systems used for this project. From these images we want to determine the total amount of axles a vehicle has and the number of axles that are in contact with the road surface. When image recognition is automated for this purpose, heavy load measurements from the [redacted] system can be checked and confirmed to be reliable. This investigation could potentially lead to the use of weight enforcement in the future. Determining the amount of axles and whether they are raised or not can be a difficult task because the contrast between the tire and the road surface is limited. Due to different weather and lighting conditions during the day this can also vary greatly between images. With AI it might be possible to teach the computer to determine whether an axle is raised or not regardless of these limiting factors. ***Detecting no vehicles moments*** For one of the [redacted]-systems ([redacted]) 2 bridges (10.000 vehicle passages/bridge/day) are installed with 20 strain sensors each that provide data at a 100 Hz frequency (and can go up to 1000 Hz). These strain measurements can be used to determine traffic load from bridge response. The data that is gathered through this system requires a large amount of storage capacity (15 GB/day), not including back-ups. So far, there is no system in place yet which can filter out the data for those moments that no vehicles are crossing the bridges. The expected reduction in data storage that can be achieved is >50%.

	With AI it may be possible to teach the computer to better recognize vehicle passages in strain measurement data of which the noise levels can sometimes be similar or greater than the net strain measurements themselves, especially in the case of light vehicles passing by. Currently the individual vehicle passages of monthly calibration records are filtered out by known time stamps of those passages because they were recorded during calibration. That is of no use however for the actual traffic. For the actual traffic recordings through sound-radar is used to determine vehicle passages. However, this system is not fool proof and can potentially miss vehicle passages. ***Data Analysis*** For this same [redacted] it is challenging to determine the bridge response due to individual axles and extract these effects from the data. The challenge lies in the fact that several axles/vehicles can influence the measurement at the same time, leading to complex structures in the strain measurements. Further complications are expected from multiple vehicles crossing a bridge simultaneously (as there are multiple lanes per bridge). This "cross-talk" in the data may lead to a lower reliability and thus a higher prediction of the traffic loads for the assessment of bridges and quay walls. AI may help to find and determine patterns in the data that have not been identified yet which can be used to improve the data analysis. Noise reduction and/or improvements in getting better fits on the data may be several paths through which data-analysis can be improved. Some previous work has already been done with [redacted] fitting when the amount of axles is known beforehand, which is also only known for the monthly calibration runs.
Work environment	Within the City of Amsterdam, you will work with experts from the Engineering Department. The student will be working from home, like the team mostly does now. They can meet up with us regularly at the office or through video calls depending on the lockdown advice from the government. They will work with people experienced in civil engineering and physics who understand the data that is being used and what they want to know from it. We have enough programming experience in our team to be able to analyze our data up to a certain point, but no experience with AI and the extra potential it may give. Once a week all AI & Data Science students gather for more in-depth technical support.

Expectations	The most important thing is to be eager to explore and learn together and step out of the comfort zone. The aim to achieve results directly applicable and relevant to the municipality. (i.e. not merely an academic paper). In addition to the delivery of useful predictive models, relevant results also include byproducts of the whole data analysis/processing pipeline that could be turned into insightful reports.