

# Exam - Spring 2024

## INFO9023: Machine Learning Systems Design

### Instructions

- Oral exam
- You will receive **1 use case** and a series of questions relating to it
- Make sure to **thoroughly read** the use case description and each question
- **Motivate** your answers. Often the reason for making a specific design choice is as important as the choice itself.
- The total grade for the exam is **30 points**. Points are announced for each questions

## Use case - Visual quality control for ChocoEclipse production line



**ChocoEclipse** is a large international chocolate producer. Their global HQ is in Brussels, but they have **5 main production plants** (in Belgium, Germany, US, Brazil and Australia). They ship and sell their products in many different markets.

Each plant produces about **100 different** chocolate derived **products** (flavors, size and shape). New products are frequently introduced.

ChocoEclipse has a long proud tradition of chocolate crafting, but now set the goal of modernizing its production line. They identified different possible use cases, one of which is to **identify and remove**

**damaged products early in the manufacturing line using AI and Computer Vision.**

The Visual Quality Control (VSQ) solution will use cameras above the production line to automatically detect if a product has a defect. The defective product can automatically be isolated and removed from the production line, avoiding costly checks and having to discard whole batches of products.

ChocoEclipse has a catalog of their different products with pictures, but not a significant amount of them.

You are part of a Data Science team setup within ChocoEclipse's IT department. You are responsible for the implementation of the solution. That includes not only implementing the Machine Learning model to detect defective products; but also designing the overall solution, collecting and processing data, automatically training and deploying models at scale, monitoring the solution and more.

The Data Science team is newly formed, there are not a lot of the practices and infrastructure yet set in place. You want to use this project as a foundation to start applying MLOps best practices.

## Question 1 - Use case definition

(5 points)

Before the project starts, you are asked to define the project using a **Machine Learning Canvas**. Present the key points of your project. Focus on:

1.1. Value proposition: *[Propose the product with the value it creates and the pain it alleviates. How will you measure the value created?]*

(1 points)

1.2. Data: *[Identify the training and production data sources, as well as the labeling process and decisions.]*

(2 points)

1.3. Evaluation: *[Design setups and metrics for testing your application during development and usage.]*

(2 points)

## Question 2 - Model deployment

(9 points)

Fast forward a few months, you successfully collected data and showed the performance of your models during a Proof of Concept. You now want to start **serving** and **deploying** your models so they can be used directly in production lines.

2.1. You are considering how and where to deploy the ML. Present and *motivate* which option makes the most sense here - give pros & cons.

(5 points)

2.2. You are asked to speed up the system so it can make predictions on a faster moving conveyor belt. . Give and explain **two ways** you can reduce the latency of your model.

(4 points)

### Question 3 - Monitoring

*(6 points)*

Fast forward, your models are now being served in production in all 5 plants. You want to be able to monitor your models.

3.1. How will you monitor the **resources** used by your system?

*(3 points)*

3.2. List the different types of **drifts** that can occur in an environment surrounding any ML system? Which ones could actually happen in this use case? Give some examples.

*(3 points)*

## Question 4 - Model & CICD Pipeline

*(10 points)*

You want to be able to retrain new models and deploy them efficiently in all five plants across the world. You and the whole Data Science team are in the Brussels headquarter, but you have a Single Point of Contact (SPOC) in the IT department in each plant. You also have multiple champions in each production plant and can ask them to label new data.

4.1. List and give a short explanation of the **typical components** of the **automated ML pipeline** you will implement to do the whole process from new product to deployed model.

*(4 points)*

4.2. Which inherent **benefit** will you gain from using a ML pipeline by opposition to having to repeat each step manually using scripts?

*(2 points)*

4.3. You want to keep adding new features and modifying your code base. Therefore, you want to design a **CICD pipeline**. Can you list the typical stages of a CICD pipeline? Which types of **tests** would you put in place before integrating a change to your code base?

*(4 points)*