Capstone Project Proposal

Juan Martitegui

Business Goals

Project Overview and Goal What is the industry problem you are trying to solve? Why use ML/AI in solving this task? Be as specific as you can when describing how ML/AI can provide value. For example, if you're labeling images, how will this help the business?	Project Name: Quality Control Visual Inspection Replacement There are a lot of industries/factories that still rely on humans visually looking at the outputs of the production process to detect defects/scratches/anomalies in the outputs of a machine or process. I believe if we train a Vision AI/ML model with pictures of "Acceptable Quality" and "Denied Quality" images we can detect pieces/units that are not good to go to customers (or the next process in the production chain) saving a lot of human hours and it's associated costs.
Business Case Why is this an important problem to solve? Make a case for building this product in terms of its impact on recurring revenue, market share, customer happiness and/or other drivers of business success.	Quality is very important for every business/factory and there are still a lot of human-eye inspections being done in too many factories. By adding cameras to the production line that take pictures of the units being produced and being able to trigger an alert to tell the human operators of the line which pieces have high chance of being low quality and should be discarded we can speed up the quality control process and save lots of human hours watching all the pieces and only focus on the "high chance of being defective" ones. This will lead to lower quality control costs, higher employee moral (as this is generally tedious repetitive work) and better quality over all and maybe we can inspect processes/pieces automatically with technology that before was not cost-effective if could only be done by humans.

Application of ML/AI What precise task will you use ML/AI to accomplish? What business outcome or objective will you achieve?	What the AI/ML model would do precisely is to label images of defective products/parts/pieces as such (“Quality Not Acceptable”) and trigger an alarm message to quality control workers to review manually those parts. As we get confident the model is well trained, we might not even need a human to re-review and validate if that piece/part/product is defective and the system could trigger a message to the production system/machine to discard it automatically without human intervention.

Success Metrics

Success Metrics What business metrics will you apply to determine the success of your product? Good metrics are clearly defined and easily measurable. Specify how you will establish a baseline value to provide a point of comparison.	The main business metric I would track is cost savings in Quality Control. Basically it would be the cost of implementing this project (cameras, machinery adaptation, etc.) vs. the cost of Human Hours saved in Quality Control. Of course we need to monitor that the Quality Control (via customer complains/rejected parts in next part of the process, etc.) is as effective or better being done with our AI/ML model than by humans.

Data

Data Acquisition Where will you source your data	The data will be sourced from putting cameras in the middle of the production line/process that take pictures of the parts/units that go through the machine.

from? What is the cost to acquire these data? Are there any personally identifying information (PII) or data sensitivity issues you will need to overcome? Will data become available on an ongoing basis, or will you acquire a large batch of data that will need to be refreshed?	Every time a part is discarded because of low quality someone in the production line will mark/label that picture as “Quality Not Acceptable” so the system will have data to learn. We will need an initial amount of data this way for every different part/unit of the process where this can be implemented and when the model is accurate it can just run with minimal refreshments.
Data Source Consider the size and source of your data; what biases are built into the data and how might the data be improved?	The data size will and source will largely depend on what type of “defect” we are trying to inspect/detect for on the pictures taken by cameras and how different is a “Quality Acceptable” picture vs a “Quality Non Acceptable” picture. Let’s say it’s scratches of painted parts a Vision AutoML might be able to detect those in not that many samples. The biases here are the ones that might be imposed by the initial classification and data labeling. If a human let’s pass defective parts/units the AI/ML will absorve that bias. Also, we need to be careful to feed data in proper way. If there are only 1% of defective/scratched parts/units… if we only serve those, the AI/ML will be biased towards not finding “Quality Non Acceptable”
Choice of Data Labels What labels did you decide to add to your data? And why did you decide on these labels versus any other option?	The decision here is fairly straight forward. This is a classification problem. I would use: “Quality Non Acceptable” “Quality Acceptable” “Quality Unknown” → this one for border/edge cases that human eye and criteria should be used

Model

Model Building	I would start using image classification models like AutoML Vision from Google. Once the model is trained

How will you resource building the model that you need? Will you outsource model training and/or hosting to an external platform, or will you build the model using an in-house team, and why?	and consistently achieve the targets set for the project to be economically feasible, will put it into live production monitoring the production line. Will then monitor the hit ratio of the model in production. To see if it's working well and make tweaks accordingly.
Evaluating Results Which model performance metrics are appropriate to measure the success of your model? What level of performance is required?	For classification models we can evaluate them with lots of metrics (accuracy, precision, f1, recall and others... for ie. cost per defect found here might be important) but in this case I will pick hit ratio as the model needs to be great at identifying "Quality Non-Acceptable" pieces or parts. I'd try to keep this as high as possible 0.985 or more. These thresholds might vary depending on the cost of letting one bad quality piece/part through (one thing is if you are talking about a scratch or something that doesn't affect functionality in something that can't affect anyone's safety, other is a piece/part that if a defect goes through can cause an accident or harm) At the end of the day, we need better level of detection than human-eye performance, at lower cost.

Minimum Viable Product (MVP)

Design What does your minimum viable product look like? Include sketches of your product.	As this is a B2B API product it will basically a back-end product to be implemented into the customer's production lines. So not need for a particular UI/UX but I'm including a sketch on how the workflow/process would look like. (see attached)
Use Cases	The main customer persona this product is aimed at is a "Factory Manager" "Production Plant Manager" or the

What persona are you designing for? Can you describe the major epic-level use cases your product addresses? How will users access this product?	heads of “Quality Control” in factories in industries like automotive, manufacturing, plastics, etc. and any other that defects can be detected by human eye and inspections are conducted by human eye. Thinking about it now it can also be used to “discard” food/fruits in that are rotten are not top quality in a packaging line for example. The product will be a backend system that will just stop/mark/alert the line workers when a “Quality Non Acceptable” piece/part was encountered and will have “pings” to stop the line (or gives instruction to the manufacture/packaging machine to discard/separate that piece or part). If not it might have a screen where after stopping the line a worker can say if that piece/part was identified correctly as Quality Non Acceptable or not creating a reinforcement loop in the ML data.
Roll-out How will this be adopted? What does the go-to-market plan look like?	After getting the first customers/clients we will go through 2 different stages for each of the

Post-MVP-Deployment

Designing for Longevity How might you improve your product in the long-term? How might real-world data be different from the training data? How will your product learn from new data? How might you employ A/B testing to improve your product?	As this Quality Control application will depend a lot on the units/parts that are being controlled, most of the training data will be “real-world” data, that means we will be training the model will real “Non Accepted Quality” pictures. For different parts that are “similar enough” or “close enough” we might be able to use a previous trained model and enhance it with new cases make it more widely applicable but in general I believe we will need to start from almost zero for each “part/unit” we are

	controlling quality for. We might employ A/B testing of the model using different Classifiers as done in project 2 of this course. Maybe we split test giving clean balanced data vs unbalanced data. Maybe we split test with some image quality enhancement/lighting or instead of a simple camera we do it with things like “heat detection” camera or some sort of other imagery to see if that improves the outcomes.
Monitor Bias How do you plan to monitor or mitigate unwanted bias in your model?	I will mitigate bias by having different human inspectors classifying the images, also by using and testing different amounts/shares of type of defects (for ie. Something maybe rejected or quality not accepted because of “scratches” others because of shape or not good finish/termination details, etc.) by adjusting the amount of these type of problems are fed into the ML for learning will reduce the bias.