

Capstone Project Proposal



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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?	<ul style="list-style-type: none">- Smart Queuing System: An application to reduce congestion in a queuing system. It can be used in retail, transportation, and manufacturing industries, it applies to many other industries like in aviation industry. It will also help know the busiest hours and make sure there are enough staffs to attend to customers, leading to customer satisfaction and improved sales.- A Computer Vision (CV) model, which is an ML/AI model, will process live feed videos from surveillance cameras and direct the queues autonomously and appropriately to avoid congestions.
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.	<ul style="list-style-type: none">- A common problem with businesses that use queues is congestion, sometimes the queues are not efficiently managed, one queue may be overloaded while another is empty or have very few people on it. It will help to effectively manage queues in many businesses.- It helps to create well-spaced queues as well as a healthy environment, especially in this period of the Covid-19 outbreak. When queues are well managed, it improves staff efficiency, attracts customers, reduces wait time, increases customer loyalty. Happy and returning customers generate steady revenue for the business.
Application of ML/AI What precise task will you use ML/AI to accomplish? What business outcome or objective	<ul style="list-style-type: none">- Computer Vision model (ML model) will be used to detect and count the number of people on every queue, If the count on a queue is below the threshold (3 people for instance), the system will alert people sitting at the reception or at a large queue to join the queue while giving space.

will you achieve?

- Building a well-organized and very effective queuing system in a business that requires queues like retail shops, banks, transportation, and manufacturing industries.

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 success of the AI product will be determined by its profit contribution and how the technology has improved sales and keeps people safe. Business performance indicators like Monthly Recurring Revenue (MRR) or Operating Cash Flow (OCF) will also be suitable when measuring the contribution of the product to the business's success.

The performance of the model will be measured with the Recall metric, which will be used to check the number of people detected out of all the people who entered each queue's video frame. Also, the Precision metric to make sure that queue video feed does not count any other object as a person other than people.

Baseline comparison will be to measure the performance and sales with the AI product and make sure it did not fall below sales without the product. Also with that, will check it with other existing similar products (say 10 different similar, already performing, products), and make sure it performs better when compared to them.

Data

<p>Data Acquisition</p> <p>Where will you source your data 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?</p>	<p>Data will be manually collected. A relatively large dataset comprising a total number of 10,972 images will be mostly captured from CCTV cameras placed in department stores, shopping malls, and retails, will be prepared. The majority of the images will be captured in indoor environments under various conditions such as distance, lighting, angle, and camera type. Given the fact that each camera has its color depth and temperature, a field of view, and resolution, all images will pass through a preprocessing operation which ensures consistency across entire input data.</p> <p>To ease and speed up the annotation process, a semi-automatic annotation mechanism that uses a Faster RCNN inception model to generate the initial annotations for each given input image will be employed. The detection results will be manually investigated and fine-tuned to ensure the reliability and integrity of the ground truth. Moreover, images with no person present will be removed from the dataset. Finally, a random sampling process will be performed over the entire image. The final dataset consists of a total number of 10,972 images with no background overlap, divided into a training set (5,790 images), testing set (2,152 images), and validation set (3,030 images).</p> <p>Reference: A Comparison of Embedded Deep Learning Methods for Person Detection 8 Jan 2019.</p> <p>Data will be collected with people/customers' consent, making sure no data of anybody that does not want to be captured is captured.</p> <p>Dataset will be acquired for the training, more data will also be available on the go that will help improve the performance of the model.</p>
<p>Data Source</p> <p>Consider the size and source of your data; what biases are built into the data and how might the data be improved?</p>	<p>Having an image with no person in it is also a bias that can make the model detect an object as a person, the images without a person will be removed.</p> <p>Images are captured in an indoor environment because the model uses will be in an indoor retail environment. Model for use in an outdoor environment will be</p>

	<p>retrained with images captured in an outdoor environment.</p> <p>Also having enough and balanced images of people of different colors for the model to properly identify people of all races.</p>
<p>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?</p>	<p>A comprehensive process is needed to have in place to convert unlabeled data into the necessary training data to teach the AI models which patterns to recognize to produce a desired outcome.</p> <p>In the training phase, images will be first annotated according to the number of people, aided by the tool that was developed to allow semi-automatic image annotation. Next, this supervised dataset is used to train a CNN-based regression model that is then expected to estimate the people count accurately.</p> <p>In the prediction phase, RGB images acquired from the camera are processed by the foreground detection algorithm. The resulting RGBP image is given as input to the trained CNN, which finally estimates the people count in real-time.</p> <p>Reference: (RetailNet: A deep learning approach for people counting and hot spots detection in retail stores).</p> <p>The data label of having a dataset with a different number of people will help serve the purpose of counting people on queue, and direct people to different and fewer queues when necessary. Other data label options, like binary classification of a person being detected or not, can help know when a person entered a space or store. But this smart queue system application is a regression model that counts people on the queue and redirects them to different queues when necessary.</p> <p>The label option is good for the regression (people count) model but might not be good enough for the classification model.</p>

Model

Model Building 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?	<p>I will build the model with an in-house team. There are already pre-trained people count models on the Intel Model Zoo that will serve the purpose. But the team (in-house) will first get their hands dirty with building the model from scratch, annotating the training data with help of research papers. Also, make use of transfer learning and then compare the performance with the existing model from the model zoo. The reason for multiple trials is to work on customization of additional features and integrate where necessary.</p> <p>The model can also be hosted on Intel Cloud in some mobile use cases or where there is not enough security to an edge server for the model inference.</p>
Evaluating Results Which model performance metrics are appropriate to measure the success of your model? What level of performance is required?	<p>The performance of the model will be measured with the Recall metric, which will be used to check the number of people detected out of all the people who entered each queue's video frame. Also, the Precision metric to make sure that queue video feed does not count any other object as a person other than people.</p> <p>People count application don't need an extremely high performance like in critical applications, like in health care which might involve life. A good performance of between 80 - 90% on both precision and recall will serve our purpose.</p>

Minimum Viable Product (MVP)

Design What does your minimum viable product look like? Include sketches of your product.	<p>The product will have a surveillance camera for each queue that can be monitored through a computer screen or 32" led TV (connected to a computer system running Ubuntu Linus OS) and a sound system that can direct customers to different queues.</p> <p>(Pictures in the folder)</p>
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<p>Use Cases</p> <p>What persona are you designing for? Can you describe the major epic-level use cases your product addresses? How will users access this product?</p>	<p>It's a product that can be used in retail, transportation, and manufacturing industries, it is also applicable to many other industries like in aviation industry.</p> <p>A common problem with systems/companies/stores that use queues is congestion, where the queues are not managed efficiently, one queue may be overloaded while another is empty. This application reduces congestion in a queuing system.</p> <p>The product can only be monitored by an employee in a company and customers can be redirected to another queue through a sound system (or through a light indicator like green indicate the queue is accepting customers and red indicates not accepting).</p>
<p>Roll-out</p> <p>How will this be adopted? What does the go-to-market plan look like?</p>	<p>A beta testing version will first be released for random companies (like retail stores, transportation, and manufacturing industries) that fit the use cases. The test will help observe unforeseen circumstances and fix the corner case before shipping for commercial use. More data and user feedback will always be collected to help improve the subsequent versions of the product.</p>

Post-MVP-Deployment

<p>Designing for Longevity</p> <p>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?</p>	<p>More features will be added to the product in the future, including feedback from users, features like:</p> <ul style="list-style-type: none"> - Traffic reporting feature: management dashboards that give full visibility into a retailer's overall traffic by the store in real-time. For example, a retailer can remotely view which stores are under, near, or over capacity with real-time accuracy.
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These insights can also help the business identify busy periods and understand the trends of customer traffic flow over time.

- Advanced queue management system: Adding this feature will ensure that customers stay safe, secure, and comfortable in their cars or outside while waiting for their turn to enter the store.

- Collection time windows: This feature allows customers to book collection times. Customers can confirm, reschedule, or cancel appointments seamlessly on their devices. It will also help prevent overcrowding and manage traffic flow.

- Order confirmation notification: With order collection solutions, retailers can notify customers when an order is ready for pick up via SMS or in-app messages. Customers can click a link in the notification when they're on their way to the store so store employees can get their orders ready.

This two-way communication process enables customers to avoid unnecessary store visits and speeds up the handover process.

Reference:

<https://blog.localz.com/using-mobile-devices-to-manage-retail-store-traffic>

Real-world data are like going to have more people per frame than training data and sometimes change in light intensity and background images.

Model retraining pipeline, a machine learning pipeline, will be provided to preprocess newly collected data and retraining of the model for better inference, which will be included in the subsequent versions.

In case when there are not previous enough data to model the solution that will capture all the use cases, A/B testing can be use test on different use cases and collect data that will help build more effective products

Monitor Bias

How do you plan to monitor or mitigate unwanted bias in your model?

Training the model in different light intensities, lighter and darker business operation time. Making sure performance is monitored with real-world data.