Capstone Project Proposal

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?	The primary objective of this project is to develop a state-of-the-art automated annotator by integrating an open-source primary detector, such as YoloV8, with the GPT-4 vision API. Initially, the primary detector identifies broad classes in images, which are then refined by GPT-4 using resized bounding boxes for detailed annotation. The system is designed to minimize human intervention and rapidly produce comprehensive and accurate annotated data. This data is crucial for training a cascaded classifier that not only offers detailed insights but also operates independently on edge devices, eliminating reliance on cloud-based services like the GPT-4 Vision API. I have conducted preliminary tests on my machine in a specific fine-grained scenario, focusing on differentiating people into categories like children, adults, and the elderly. It's important to note that this system has the potential to generalize across multiple domains.
Business Case Why is this an important problem to solve? Make a case for building this product in terms	Implementing this automated annotator system brings substantial benefits: 1. Cost-Effective Solution: Automation drastically cuts down on labor and

of its impact on recurring revenue, market share, customer happiness and/or other drivers of business success.	operational costs associated with manual annotation and cloud dependencies(Note that we have to use the API once for the annotation). 2. Enhanced Accuracy and Data Depth: The dual-system approach of using a primary detector and GPT-4 ensures highly detailed and precise data annotation, crucial for various industries. 3. Operational Independence and Efficiency: The ability of the resultant classifier to run on edge devices enhances operational efficiency and reduces reliance on cloud services.
Application of ML/AI What precise task will you use ML/AI to accomplish? What business outcome or objective will you achieve?	The project employs ML/AI to: 1. Combine Broad and Nuanced Annotations: Utilizing a primary detector for general classification followed by GPT-4 for fine-grained annotation ensures comprehensive data coverage. 2. Facilitate Rapid, High-Quality Data Collection: The automated system's efficiency allows for quick collection of annotated data from open datasets itself, essential for training a robust cascaded classifier. 3. Enable Edge-Based, Customized Solutions: The trained classifier, capable of operating on edge devices, can be tailored to specific primary detectors and use cases, offering businesses flexibility and independence from cloud services.

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.	**Annotation Accuracy Rate:** **Definition**: Proportion of correctly classified annotations by the system autonomously. **Baseline**: Compare with a manually annotated test dataset for initial accuracy reference. **Time and Cost Savings:** **Definition**: Reduction in annotation time and costs versus traditional methods. **Baseline**: Evaluate current manual or less advanced automated annotation processes for efficiency comparison. **Classifier Performance on Edge Devices:** **Definition**: Effectiveness and speed of the classifier on edge devices, without cloud dependency. **Baseline**: Compare with existing classifiers or cloud-reliant systems for performance benchmarking. **Customer Adoption and Satisfaction Rate:** **Definition**: New customer adoption rate and satisfaction based on feedback and retention. **Baseline**: Contrast with adoption rates and feedback from previous or competing products.

	Reduction in Cloud Dependency: **Definition**: Increase in market share and revenue from the automated annotator. **Baseline**: Analyze market share and revenue from existing or past products for growth assessment.

Data

Data Acquisition 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?	Data Sourcing: • Combination of open datasets and custom acquisition from businesses. • Open datasets for foundational images; custom data for specific use cases. • Continuous updates for relevance and adaptability. Cost of Data Acquisition: • Variable costs: Free for open datasets, varying for custom business data. • Resource allocation for preprocessing and integration. Addressing PII and Data Sensitivity: • Implementing data anonymization techniques for human images. • Compliance with privacy standards and ethical data use. Availability and Refresh of Data: • Continuously gather from open and custom business sources. With the current data

	driven world, open data source can be obtained in variety of ways.
Data Source Consider the size and source of your data; what biases are built into the data and how might the data be improved?	Size and Source Considerations: • Large and diverse, sourced from various environments for comprehensive coverage (Kaggle/academic sources). • Balancing open datasets and business-specific data. Addressing Biases: • Ensuring balanced representation from diverse sources (under sampling). • Continuous monitoring and updating to mitigate emerging biases with algorithmic approaches set alerts for highly imbalanced data.

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?
	Selected Labels for Human Classification:
	This is only for explanation; we could use it for multiple classification problems. Here's a made-up example.
	• Children, Adults, Elderly from the person class detected by primary detector like Yolov8
	
	Project-Class-Agnostic Approach:
	• Versatile and adaptable for various classification tasks.
	• Examples of potential applications:
	  • Flower species classification.
	  • Manufacturing defect detection.
	  • Clothing types in retail.

	• Vehicle types in transportation. • Food item categorization. • Animal species identification. • Architectural style recognition. • Medical imaging analysis (e.g., X-rays, MRI scans). • Environmental feature classification (e.g., landforms, vegetation types). Flexibility and Adaptability: • Customizable with new labels for different industries. • Future-proofing the technology for emerging trends and needs.

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?	**Approach:** In-house implementation is chosen for high level customization, control, and cost-effectiveness except for the API service from GPT4 Vision API. Also, we have enough technical expertise in the problem we're trying to solve. **Advantages:** Tailored fit for project needs, effective use of my team's skillset, and full intellectual property control.

Evaluating Results Which model performance metrics are appropriate to measure the success of your model? What level of performance is required?	Key Metrics: Accuracy, Precision and Recall, F1 Score, and Speed of Classification on Edge Devices with already available test sets. Performance Goals: High accuracy for reliable annotations, balanced precision and recall for comprehensive classification, and optimized performance for edge device deployment.

Minimum Viable Product (MVP)

Design What does your minimum viable product look like? Include sketches of your product.	User Interface (UI): A simple, intuitive UI for uploading images and viewing annotations. **[MAIN PRODUCT] Annotation Engine**: Integrates the primary detector like Yolov8 and GPT-4 for automated annotation. Data Management: Handles data input, processing, and output efficiently. Reporting Dashboard: Provides insights and metrics on annotation accuracy and efficiency. Here's the chart created with the mermaid language [link] for explaining the flow of the product.

Use Cases

What persona are you designing for? Can you describe the major epic-level use cases your product addresses? How will users access this product?

Persona:

- Designed for product managers and data scientists in industries like retail, manufacturing, and healthcare who need detailed image annotations.

Major Epic-Level Use Cases:

1. Retail: Automating product categorization and customer demographic analysis.
2. Manufacturing: Identifying defects or categorizing parts in production lines.
3. Healthcare: Analyzing medical images for preliminary diagnosis or research.

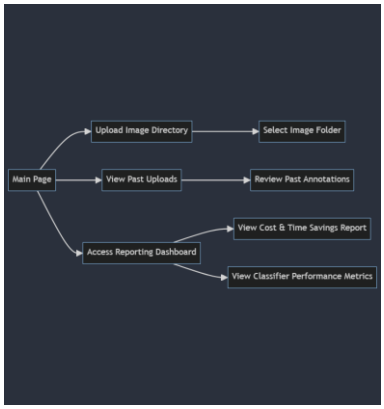
Access to Product:

- Accessed via a web-based platform for annotation, ensuring ease of use and compatibility with various devices and

operating systems. Final deployment in the devices like NVIDIA Jetson

Here is a breakdown of the flow into easily understandable parts. Please refer to the main product diagram above, and then review these detailed sections.

- UI



- Annotation process

	• Dashboard 
Roll-out How will this be adopted? What does the go-to-market plan look like?	Adoption Strategy: • Pilot Testing: Start with pilot projects in target industries to gather feedback and refine the product. • Partnerships: Collaborate with industry leaders for credibility and wider reach. Go-to-Market Plan: • Marketing Campaigns: Focused on industry-specific needs and the benefits of automated, accurate annotation. • Demonstrations and Workshops: To showcase the product's capabilities and engage potential customers. • Customer Feedback Loop: To continuously improve the product based on real-world usage.

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?	Active Learning: Implement active learning to adapt to new, real-world data where the current model is weak based on confidence score, To maintain accuracy and relevance. A/B Testing: Utilize A/B testing to refine models and annotation strategies based on user feedback and performance metrics.
Monitor Bias How do you plan to monitor or mitigate unwanted bias in your model?	Regular Audits: Perform periodic audits to identify and address model biases. • Diverse Data Sources: Ensure training on balanced datasets from varied settings. • Algorithmic Checks: Implement checks within the algorithm for potential imbalance biases.