

# INTRODUCTION

## 1.1 Project Overview

GrainPalette is an innovative project aimed at developing an intelligent mobile and/or web application for accurate rice type classification using image analysis. Recognizing the need for a readily available and user-friendly tool for rice identification among farmers, agricultural scientists, home gardeners, and others, GrainPalette leverages the power of Artificial Intelligence and Deep Learning.

At its core, the application allows users to upload images of rice grains via their devices. The system then employs a pre-trained MobileNetv4 model, fine-tuned using Transfer Learning on a specialized rice grain image dataset, to rapidly analyze the image and predict the specific type of rice with a high degree of accuracy (achieving approximately 98% validation/test accuracy). The application is designed to provide instant results, potentially accompanied by relevant farming tips tailored to the identified rice variety, such as water and fertilizer requirements.

The development of GrainPalette follows a focused, sprint-based approach to meet a project deadline of March 13th, 2025. The technology stack includes a robust backend likely built with Python frameworks (e.g., Flask) to handle image processing and model inference, and a user-friendly frontend interface developed with technologies like React. Future enhancements may include features like user feedback mechanisms to improve model accuracy, user history dashboards, and administrative tools for model management and analytics. Ultimately, GrainPalette strives to empower users with knowledge about rice varieties, potentially leading to better agricultural practices and outcomes.

## 1.2 Purpose

The primary purpose of the GrainPalette project is to address the existing gap in easily accessible and accurate methods for identifying various types of rice grains. Traditional methods often require specialized knowledge or laboratory analysis, which may not be readily available to many potential users, particularly farmers in remote areas or individuals with a general interest in rice varieties. GrainPalette aims to democratize rice identification by providing a user-friendly and efficient solution through a mobile and/or web application.

By leveraging the advancements in Artificial Intelligence and Deep Learning, specifically utilizing Transfer Learning with the MobileNetv4 architecture, GrainPalette offers a rapid and highly accurate method for classifying rice types based on uploaded images. This capability empowers users to quickly gain knowledge about the specific variety of rice they possess or encounter.

The project's purpose extends beyond simple identification. By potentially integrating farming tips and relevant information for each identified rice type, GrainPalette seeks to contribute to improved agricultural practices, better decision-making regarding cultivation, and ultimately, enhanced yields and sustainability in rice farming. Furthermore, it serves as a valuable educational tool, increasing awareness and understanding of the diversity within rice varieties.

for a broader audience.<sup>1</sup> In essence, GrainPalette strives to harness the power of AI to bridge the knowledge gap in rice identification and foster positive impacts across agricultural and educational domains.

## Ideation Phase

### Define the Problem Statements

Date	5 March 2025
Team ID	PNT2025TMID00864
Project Name	GrainPalette A Deep Learning Odyssey In Rice Type Classification Through Transfer Learning
Maximum Marks	2 Marks

#### **Customer Problem Statement Template:**

Create a problem statement to understand your customer's point of view. The Customer Problem Statement template helps you focus on what matters to create experiences people will love.

A well-articulated customer problem statement allows you and your team to find the ideal solution for the challenges your customers face. Throughout the process, you'll also be able to empathize with your customers, which helps you better understand how they perceive your product or service.

<b>I am</b>	Describe customer with 3-4 key characteristics - who are they?	Describe the customer and their attributes here
<b>I'm trying to</b>	List their outcome or "job" the care about - what are they trying to achieve?	List the thing they are trying to achieve here
<b>but</b>	Describe what problems or barriers stand in the way - what bothers them most?	Describe the problems or barriers that get in the way here
<b>because</b>	Enter the "root cause" of why the problem or barrier exists - what needs to be solved?	Describe the reason the problems or barriers exist
<b>which makes me feel</b>	Describe the emotions from the customer's point of view - how does it impact them emotionally?	Describe the emotions the result from experiencing the problems or barriers

Reference: <https://miro.com/templates/customer-problem-statement/>

#### **Example:**



# GrainPalette

## Customer Problem Statement Template

I am	I'm trying to	But	Because	Which makes me feel
A small-scale rice farmer	Identify the exact rice variety I'm cultivating	I can't afford to hire agricultural experts	Their fees are too high for my limited budget	Anxious about wasting water, fertilizer, and time
A home gardener	Grow rice efficiently in my backyard	I don't know which practices suit my rice type	Online guides are generic and unhelpful	Frustrated and unsure of my harvest
An agriculture scientist	Collect data on regional rice diversity at scale	Manual classification is slow and error-prone	Field teams lack tools for rapid analysis	Overwhelmed by inefficiencies

## Ideation Phase

### Empathize & Discover

Date	4 March 2025
Team ID	PNT2025TMID00864
Project Name	GrainPalette A Deep Learning Odyssey In Rice Type Classification Through Transfer Learning
Maximum Marks	4 Marks

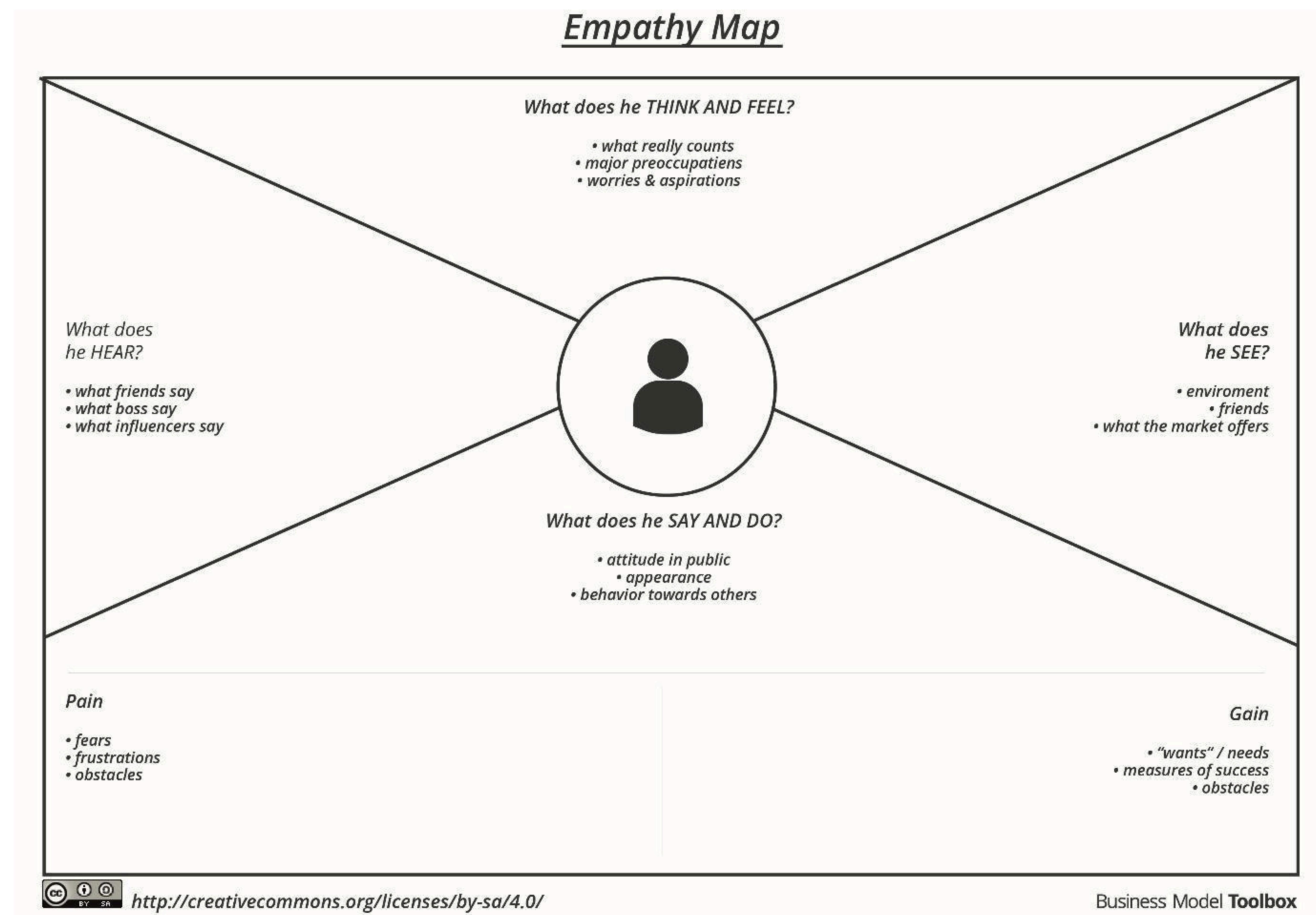
#### **Empathy Map Canvas:**

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes.

It is a useful tool to helps teams better understand their users.

Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.

#### **Example:**




Reference: <https://www.mural.co/templates/empathy-map-canvas>



## Develop shared understanding and empathy

Summarize the data you have gathered related to the people that are impacted by your work. It will help you generate ideas, prioritize features, or discuss decisions.



## Ideation Phase

### Brainstorm & Idea Prioritization Template

Date	4 March 2025
Team ID	PNT2025TMID00864
Project Name	GrainPalette A Deep Learning Odyssey In Rice Type Classification Through Transfer Learning
Maximum Marks	4 Marks

**Brainstorm & Idea Prioritization Template:** Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions.

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

Reference: <https://www.mural.co/templates/brainstorm-and-idea-prioritization>

#### Step-1: Team Gathering, Collaboration and Select the Problem Statement

The screenshot shows the initial stage of a Mural template for a Brainstorm & Idea Prioritization session. On the left, there's a sidebar with a lightbulb icon and the title "Brainstorm & idea prioritization". Below it, instructions say: "Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room." It also lists preparation time: "10 minutes to prepare", "1 hour to collaborate", and "2-8 people recommended".

The main area is divided into two columns. The left column, titled "Before you collaborate", contains three steps: "A Team gathering", "B Set the goal", and "C Learn how to use the facilitation tools". Each step has a brief description and a "Open article" button. The right column, titled "Define your problem statement", shows a box labeled "PROBLEM" containing the placeholder "How might we [your problem statement]?".

At the bottom right, there's a box titled "Key rules of brainstorming" with six rules: Stay in topic, Encourage wild ideas, Defer judgment, Listen to others, Go for volume, and If possible, be visual.

1

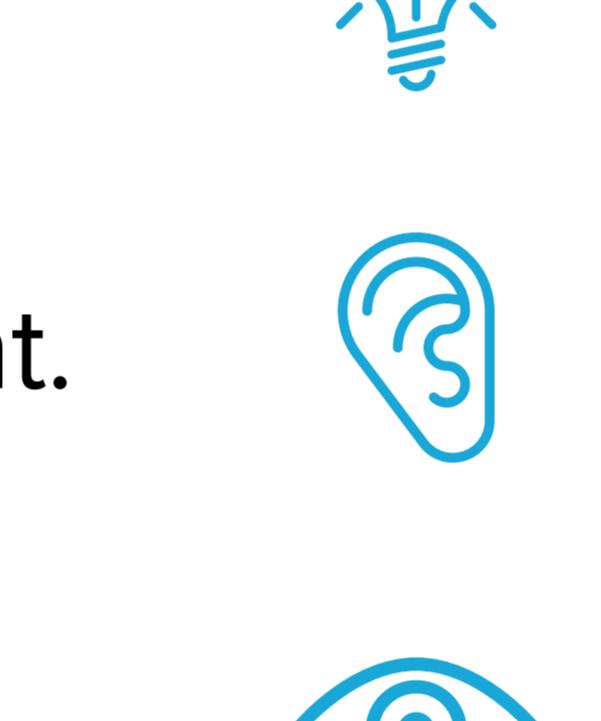
## Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

⌚ 5 minutes

### PROBLEM

How might we make accurate rice type identification affordable and accessible to all farmers, regardless of their resources?

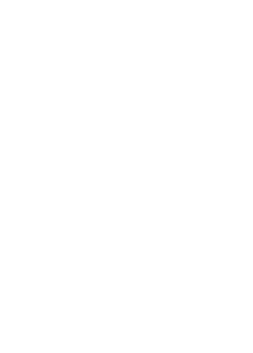


### Key rules of brainstorming

To run an smooth and productive session



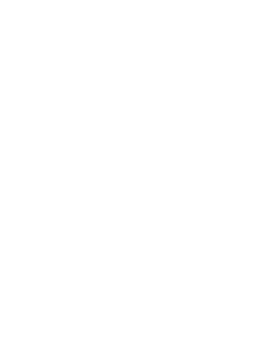
Stay in topic.



Encourage wild ideas.



Defer judgment.



Listen to others.



Go for volume.



If possible, be visual.

## Brainstorm

Write down any ideas that come to mind that address your problem statement.

⌚ 10 minutes

### TIP



You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

### Kunal Goel

Improve the offline mode so it can do more processing locally, even if the initial model download needs internet.

Allow farmers to anonymously contribute rice grain images to a community dataset to improve model accuracy over time.

Add support for more local languages beyond just the most common ones.

Include short videos or guides within the app explaining rice types and farming practices.

Make the image capture process a little game to teach farmers how to take good pictures for accurate AI analysis.

Allow farmers to anonymously contribute rice grain images to a community dataset to improve model accuracy over time.

### Ayush Mishra

After rice type prediction, show current market prices for that rice type in local markets.

Investigate if there are even more efficient, open-source transfer learning models we could use to reduce app size and processing needs.

Make the app interface extremely basic with large icons, minimal text – think grandpa-friendly!

Explore partnerships with mobile network providers to offer discounted data packs specifically for agricultural apps like ours.

Create a simplified, smaller app version that uses less data and works better on basic smartphones.

Collect and share success stories from farmers who have used GrainPalette and seen positive results to build trust and encourage adoption.

### Aashish Kumar Chetan

Offer a basic free version with limited daily predictions, and a premium subscription for unlimited use and extra features.

Actively pursue government grants or subsidies for agricultural technology initiatives to make the app free or heavily discounted for farmers.

Partner with local agricultural content creators (YouTubers, bloggers, etc.) to promote the app in regional languages and styles.

In very resource-poor areas, explore partnerships to offer extremely basic, low-cost smartphones pre-loaded with the GrainPalette app.

Set up a system for automatically retraining the AI model with new farmer-contributed data to keep improving accuracy over time.

Make the app show a "confidence score" for each prediction, so farmers know how certain the AI is.

### Abhijeet Singh Adhikari

Partner with agricultural NGOs who work directly with farmers to distribute the app and provide training.

Direct button in the app to connect to a human agricultural expert for more complex questions (maybe a paid premium feature, or limited free initial consultations).

Instead of just MobileNetV4, experiment with combining multiple transfer learning models for potentially higher accuracy (but might increase complexity).

Easy way for farmers to report if the prediction was wrong and ideally, provide the correct rice type, to use as error correction data.

Provide downloadable guides (PDF or video) on how to collect and photograph rice grains for best AI analysis.

Collaborate with fertilizer/seed companies to bundle app access with their products.



## Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

⌚ 20 minutes

### TIP

Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.

### Enhancing Core App Functionality & AI

Improve the offline mode so it can do more processing locally, even if the initial model download needs internet.

Investigate if there are even more efficient, open-source transfer learning models we could use to reduce app size and processing needs.

Allow farmers to anonymously contribute rice grain images to a community dataset to improve model accuracy over time.

Instead of just MobileNetV4, experiment with combining multiple transfer learning models for potentially higher accuracy (but might increase complexity).

Set up a system for automatically retraining the AI model with new farmer-contributed data to keep improving accuracy over time.

Easy way for farmers to report if the prediction was wrong and ideally, provide the correct rice type, to use as error correction data.

### Simplifying User Experience & Providing Guidance

Provide downloadable guides (PDF or video) on how to collect and photograph rice grains for best AI analysis.

Include short videos or guides within the app explaining rice types and farming practices.

Make the app interface extremely basic with large icons, minimal text – think grandpa-friendly!

Make the image capture process a little game to teach farmers how to take good pictures for accurate AI analysis.

Make the app show a "confidence score" for each prediction, so farmers know how certain the AI is.

### Strategic Partnerships & Distribution

In very resource-poor areas, explore partnerships to offer extremely basic, low-cost smartphones pre-loaded with the GrainPalette app.

Explore partnerships with mobile network providers to offer discounted data packs specifically for agricultural apps like ours.

Partner with agricultural NGOs who work directly with farmers to distribute the app and provide training.

Actively pursue government grants or subsidies for agricultural technology initiatives to make the app free or heavily discounted for farmers.

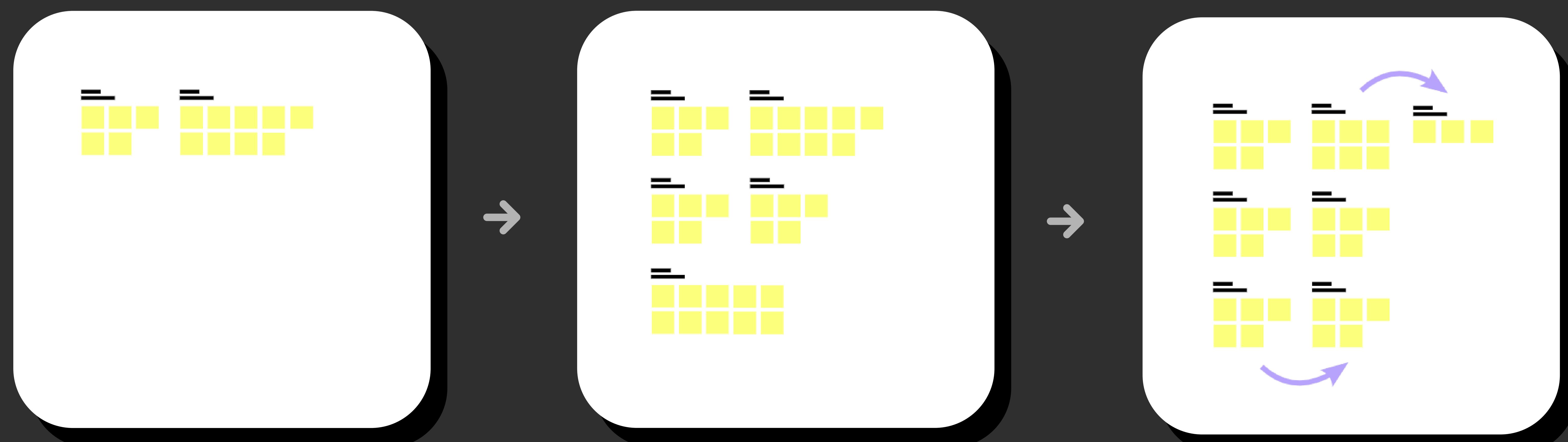
### Adding Farmer Value & Practical Features

Add support for more local languages beyond just the most common ones.

Direct button in the app to connect to a human agricultural expert for more complex questions (maybe a paid premium feature, or limited free initial consultations).

Offer a basic free version with limited daily predictions, and a premium subscription for unlimited use and extra features.

After rice type prediction, show current market prices for that rice type in local markets.



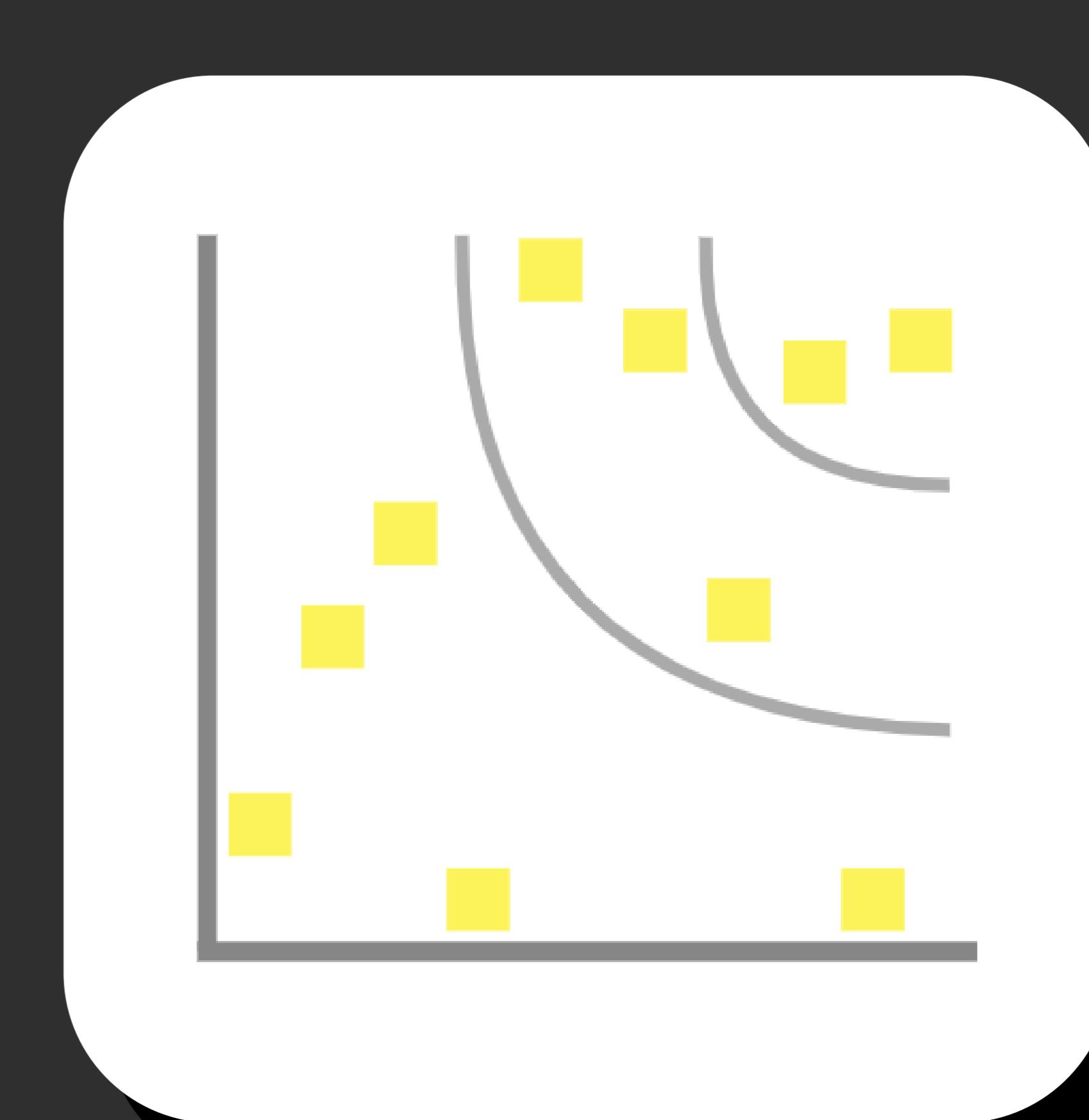
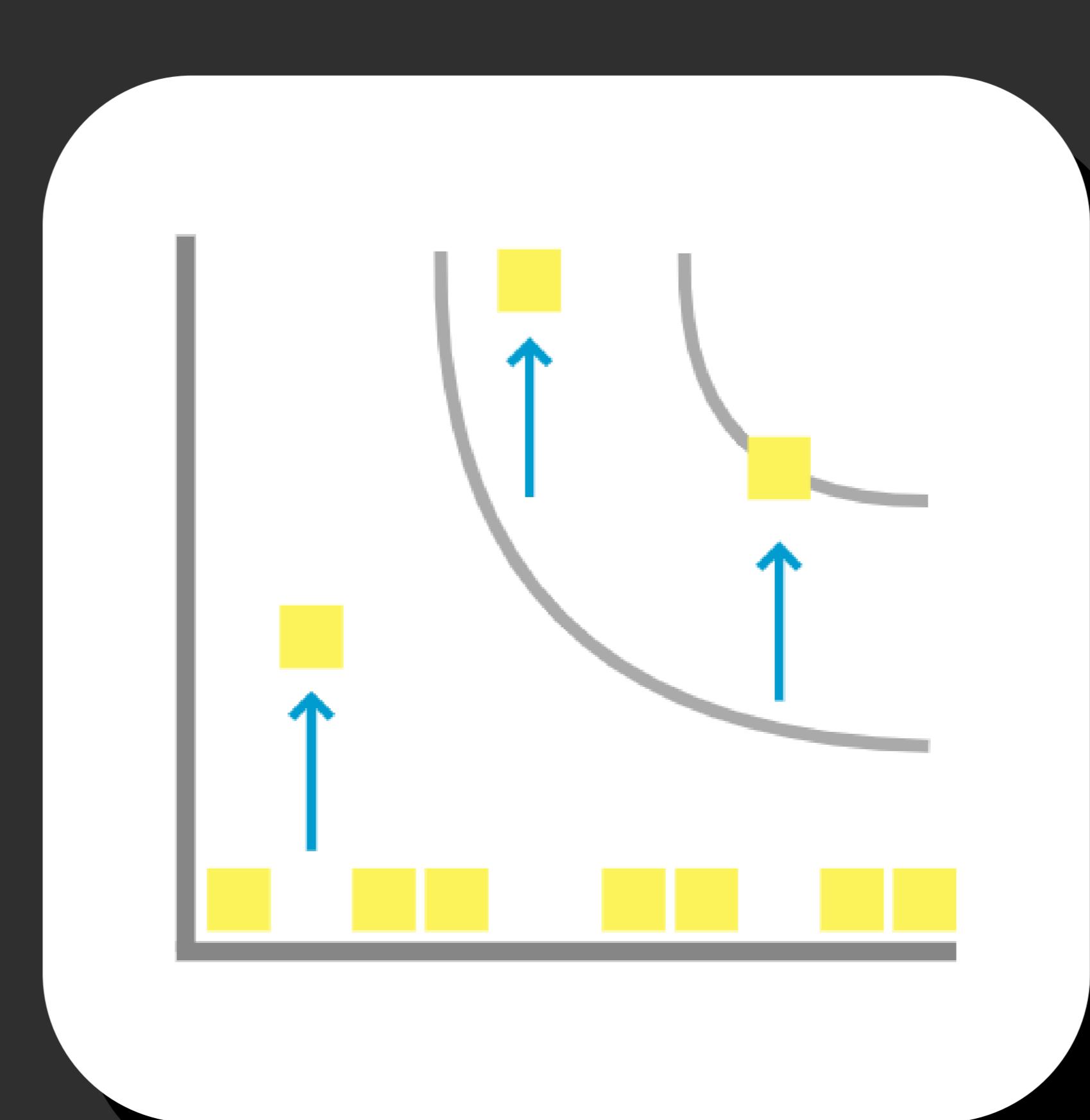
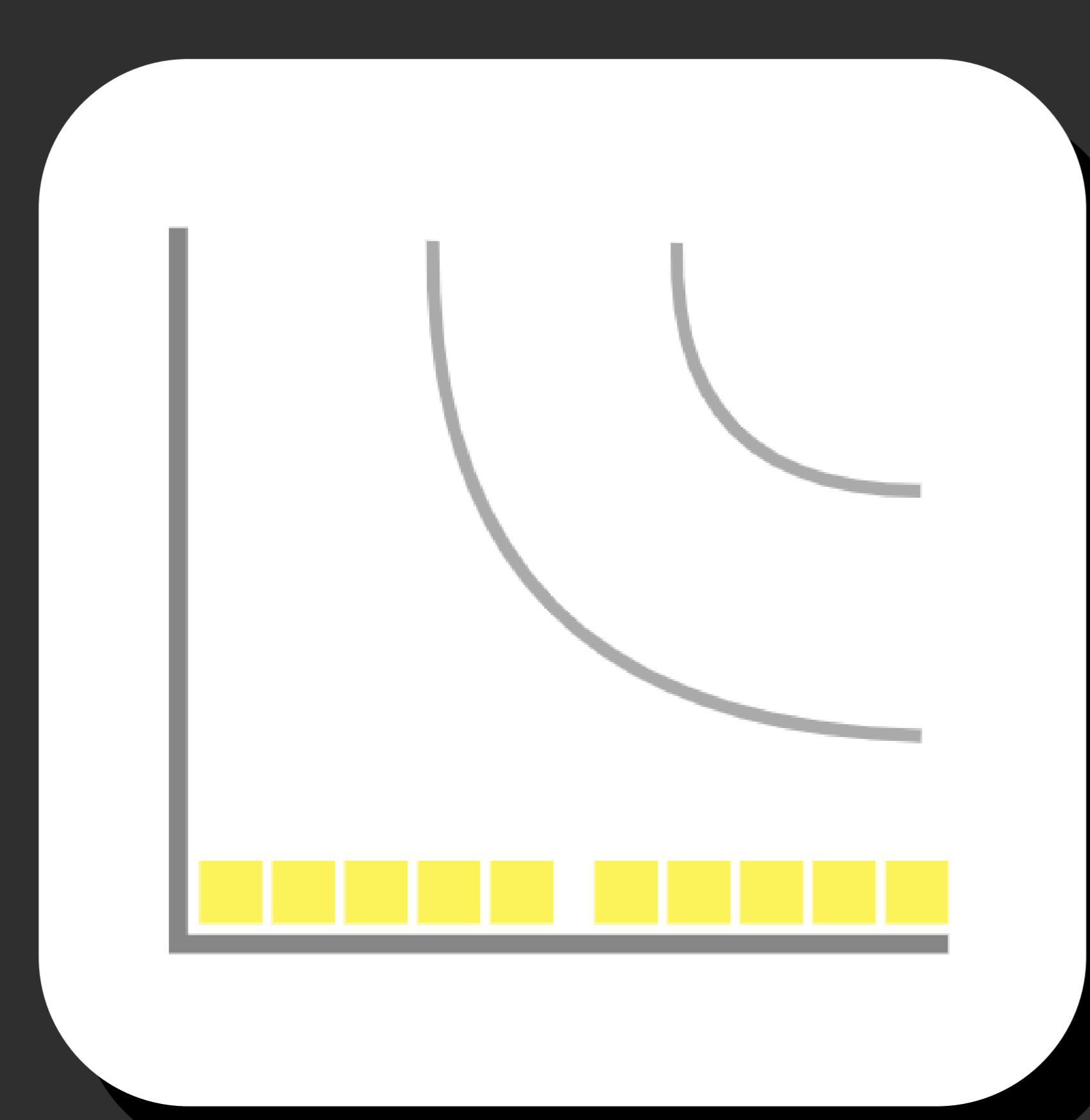
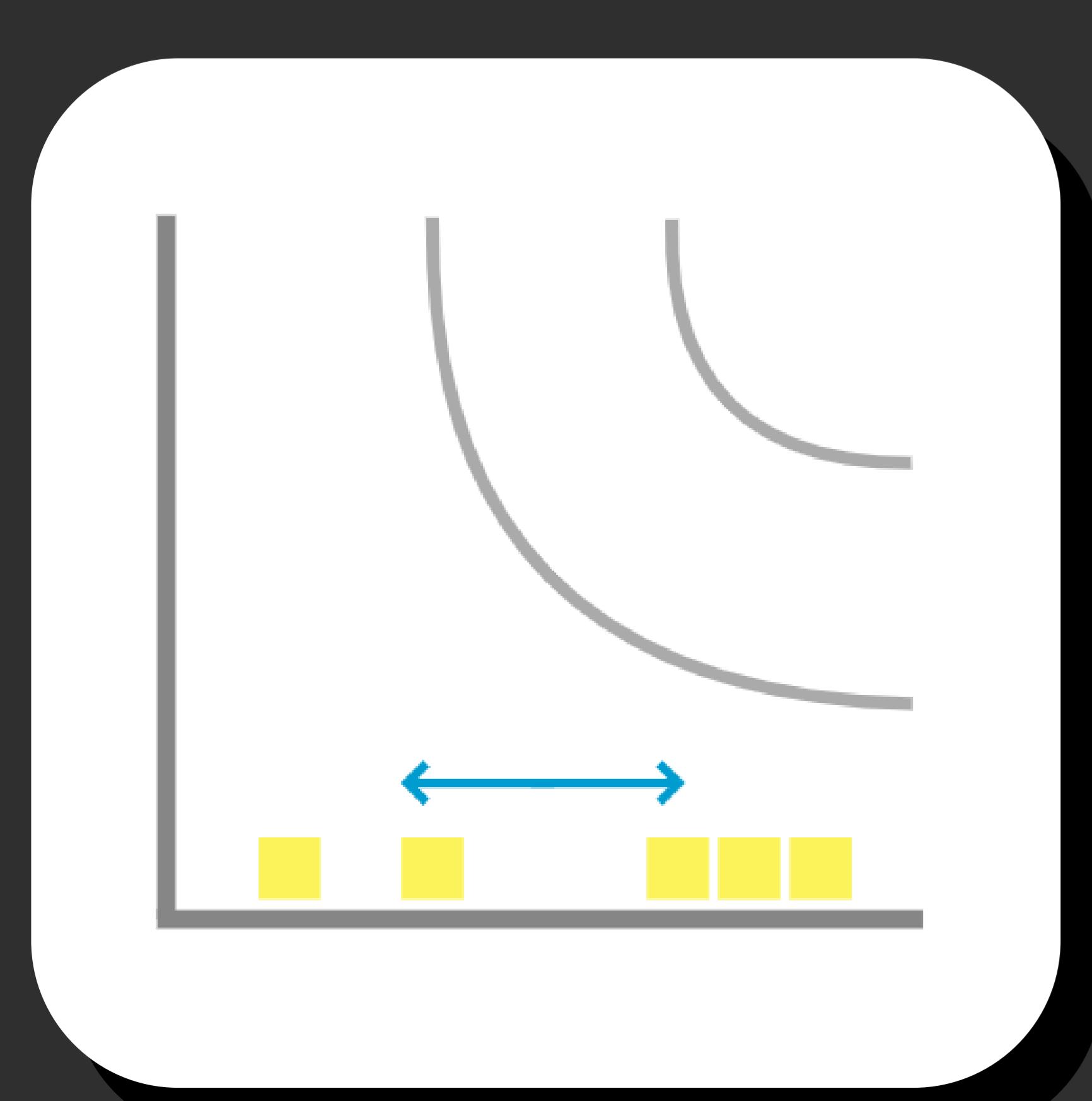

## Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

⌚ 20 minutes

### TIP

Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the **H key** on the keyboard.



<p><b>Scenario:</b> [Existing experience through a product or service]</p>	<p><b>Entice</b> How does someone become aware of this service?</p>	<p><b>Enter</b> What do people experience as they begin the process?</p>	<p><b>Engage</b> In the core moments in the process, what happens?</p>	<p><b>Exit</b> What do people typically experience as the process finishes?</p>	<p><b>Extend</b> What happens after the experience is over?</p>
<p><b>Experience steps</b> What does the person (or people) at the center of this scenario typically experience in each step?</p>	<ul style="list-style-type: none"> <li>Farmers hear about GrainPalette through local agricultural networks or social media, sparking curiosity about its cost-saving potential.</li> <li>Skepticism arises due to unfamiliarity with AI tools, leading to comparisons with traditional expert consultations.</li> </ul>	<ul style="list-style-type: none"> <li>First-time users navigate a simple interface to upload images but may feel overwhelmed if instructions are unclear or technical.</li> </ul>	<ul style="list-style-type: none"> <li>Satisfaction when the image uploads smoothly and results arrive quickly, providing immediate actionable insights (e.g., water requirements).</li> <li>Anxiety if the tool flags poor image quality or misclassifies rice types, requiring retries or manual adjustments.</li> <li>Farmers receive real-time feedback (e.g., "Adjust lighting" or "Focus on a single grain") during image upload, helping them improve photo quality and feel supported by the tool's responsiveness.</li> </ul>	<ul style="list-style-type: none"> <li>Confidence grows after receiving clear, visual-based recommendations that align with their farming knowledge.</li> </ul>	<ul style="list-style-type: none"> <li>Pride in sharing success stories with peers, becoming advocates for the tool within their community.</li> <li>Disappointment if feedback feels ignored (e.g., no updates on requested features like new rice varieties).</li> </ul>
<p><b>Interactions</b> What interactions do they have at each step along the way?</p> <ul style="list-style-type: none"> <li><b>People:</b> Who do they see or talk to?</li> <li><b>Places:</b> Where are they?</li> <li><b>Things:</b> What digital touchpoints or physical objects do they use?</li> </ul>	<ul style="list-style-type: none"> <li>Talk to peers at local farming cooperatives or watch social media influencers demo the tool.</li> <li>Agricultural fairs, community WhatsApp groups, or village meetings.</li> </ul>	<ul style="list-style-type: none"> <li>Seek help from family members (e.g., tech-savvy relatives) or customer support chatbots.</li> </ul>	<ul style="list-style-type: none"> <li>Collaborate with neighboring farmers to capture clear grain images or troubleshoot errors.</li> <li>In-app camera with auto-focus prompts and image-quality indicators.</li> <li>Pop-up notifications advising adjustments (e.g., "Zoom in for better accuracy").</li> </ul>	<ul style="list-style-type: none"> <li>Consult local agriculture officers to cross-verify AI recommendations.</li> </ul>	<ul style="list-style-type: none"> <li>Share success stories with village leaders or in farming WhatsApp groups.</li> <li>Community training sessions or regional agriculture workshops.</li> </ul>
<p><b>Goals &amp; motivations</b> At each step, what is a person's primary goal or motivation? ("Help me..." or "Help me avoid...")</p>	<ul style="list-style-type: none"> <li>"Help me find a cost-effective way to identify rice types without relying on expensive experts."</li> <li>"Help me avoid wasting time on unreliable solutions that don't work for small-scale farming."</li> </ul>	<ul style="list-style-type: none"> <li>"Help me understand how to use the tool quickly so I can start saving money today."</li> </ul>	<ul style="list-style-type: none"> <li>"Help me get accurate rice type predictions to make informed decisions about water and fertilizer."</li> <li>"Help me avoid mistakes in capturing or uploading images that could lead to wrong results."</li> <li>"Help me resolve issues quickly during usage so I can trust the tool's results without second-guessing."</li> </ul>	<ul style="list-style-type: none"> <li>"Help me apply the AI recommendations correctly to improve my crop yield this season."</li> </ul>	<ul style="list-style-type: none"> <li>"Help me share my success with other farmers to build trust in this tool."</li> <li>"Help me avoid feeling ignored if I report issues or suggest improvements."</li> </ul>
<p><b>Positive moments</b> What steps does a typical person find enjoyable, productive, fun, motivating, delightful, or exciting?</p>	<ul style="list-style-type: none"> <li>Farmers feel hopeful when learning about GrainPalette's potential to replace costly expert consultations, sparking excitement about future savings.</li> <li>Hearing success stories from trusted farmers in their community motivates them to try the tool.</li> </ul>	<ul style="list-style-type: none"> <li>Users feel accomplished when the app's intuitive design lets them upload their first image without technical hiccups.</li> </ul>	<ul style="list-style-type: none"> <li>Farmers enjoy the thrill of receiving accurate predictions within seconds, making them feel tech-savvy and efficient.</li> <li>Real-time feedback (e.g., "Great photo quality!") during image upload feels rewarding and educates users on best practices.</li> <li>Farmers feel motivated when the tool not only identifies the rice type but also provides tailored farming tips (e.g., "This variety thrives with 20% less water"), turning a simple classification into a actionable roadmap for better crop management.</li> </ul>	<ul style="list-style-type: none"> <li>Seeing clear, visual recommendations (e.g., color-coded fertilizer ratios) excites users, as they can immediately act to improve crop health.</li> </ul>	<ul style="list-style-type: none"> <li>Farmers feel proud when peers applaud their improved yields, turning them into local advocates for GrainPalette.</li> <li>Excitement grows when users see their feedback (e.g., requests for new rice varieties) implemented in app updates.</li> </ul>
<p><b>Negative moments</b> What steps does a typical person find frustrating, confusing, angering, costly, or time-consuming?</p>	<ul style="list-style-type: none"> <li>Farmers feel frustrated by conflicting reviews or misinformation about AI tools, making it hard to trust GrainPalette's promises.</li> <li>Anger arises when marketing materials use jargon, alienating non-tech-savvy users who fear the tool is too complex.</li> </ul>	<ul style="list-style-type: none"> <li>Users waste time deciphering unclear tutorials or poorly translated guides, delaying their first use.</li> </ul>	<ul style="list-style-type: none"> <li>Repeated rejections of blurry or poorly lit photos annoy users, forcing multiple retries and wasting time.</li> <li>Anger flares when the tool misidentifies rice types, leading to distrust in its recommendations.</li> <li>Frustration mounts if predictions take longer than advertised, especially during urgent farming decisions.</li> </ul>	<ul style="list-style-type: none"> <li>Confusion erupts when results include terms like "NPK ratios" without simple explanations, leaving users unsure how to act.</li> </ul>	<ul style="list-style-type: none"> <li>Users feel ignored when their suggestions (e.g., adding new rice types) go unanswered, breeding resentment.</li> <li>Embarrassment if advocating for the tool backfires (e.g., neighbors blame them for crop issues caused by AI errors).</li> </ul>
<p><b>Areas of opportunity</b> How might we make each step better? What ideas do we have? What have others suggested?</p>	<ul style="list-style-type: none"> <li>How? Create short, jargon-free video testimonials from respected farmers or local agriculture officers showcasing GrainPalette's success.</li> <li>Partner with NGOs to distribute pamphlets in regional dialects, emphasizing cost savings over technical jargon.</li> </ul>	<ul style="list-style-type: none"> <li>How? Develop voice-guided tutorials for illiterate users and offline PDF guides for low-connectivity areas.</li> </ul>	<ul style="list-style-type: none"> <li>How? Integrate AI-powered real-time feedback (e.g., "Adjust camera angle") during image capture to reduce retakes.</li> <li>Add a "Retake" button with auto-captions explaining why a photo failed (e.g., "Blurry—hold steady!").</li> <li>Transforms the tool from a standalone AI into a collaborative platform, addressing user doubts while strengthening communal knowledge-sharing.</li> </ul>	<ul style="list-style-type: none"> <li>How? Replace technical terms with visuals (e.g., water droplets for irrigation needs) and link to voice-narrated guides in local languages.</li> </ul>	<ul style="list-style-type: none"> <li>How? Launch a farmer-led WhatsApp group moderated by GrainPalette to share updates and address feedback publicly.</li> <li>Gamify advocacy with referral rewards (e.g., free soil-testing kits for every 5 successful sign-ups).</li> </ul>
					<p><b>See an example</b></p>

**Project Design Phase-II**  
**Solution Requirements (Functional & Non-functional)**

Date	3 March 2025
Team ID	PNT2025TMID00864
Project Name	GrainPalette A Deep Learning Odyssey In Rice Type Classification Through Transfer Learning
Maximum Marks	4 Marks

**Functional Requirements:**

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIn
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Image Upload & Processing	Upload rice grain image Validate image format/size (e.g., JPG/PNG, ≤5MB) Process image using MobileNetv4 AI model
FR-4	Result Display & Recommendations	Display rice type prediction (top 5 classes) Provide cultivation recommendations (water, fertilizer, etc.) Export results as PDF/SMS
FR-5	Feedback & Accuracy Reporting	Allow users to report misclassifications Collect user ratings for predictions

**Non-functional Requirements:**

Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	<b>Usability</b>	Intuitive interface for non-tech users (e.g., farmers), with multilingual support (e.g., Hindi, Tamil) and voice-guided tutorials.
NFR-2	<b>Security</b>	Encrypt user data and uploaded images; implement OTP-based authentication to prevent unauthorized access.
NFR-3	<b>Reliability</b>	99% uptime during critical farming seasons (planting/harvesting) with error handling for poor connectivity.
NFR-4	<b>Performance</b>	Predictions delivered within 5 seconds even on low-bandwidth networks (<2 Mbps).
NFR-5	<b>Availability</b>	Offline mode for image uploads; sync results when connectivity resumes.
NFR-6	<b>Scalability</b>	Support 10,000+ concurrent users during peak seasons and expandable to new rice varieties.

## Project Design Phase-II

### Data Flow Diagram & User Stories

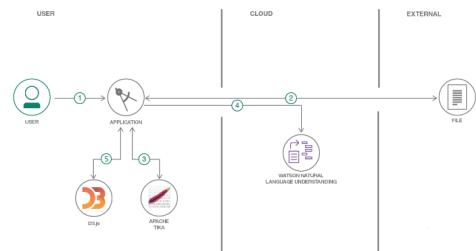
Date	4 March 2025
Team ID	PNT2025TMID00864
Project Name	GrainPalette A Deep Learning Odyssey In Rice Type Classification Through Transfer Learning
Maximum Marks	4 Marks

#### Data Flow Diagrams:

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.

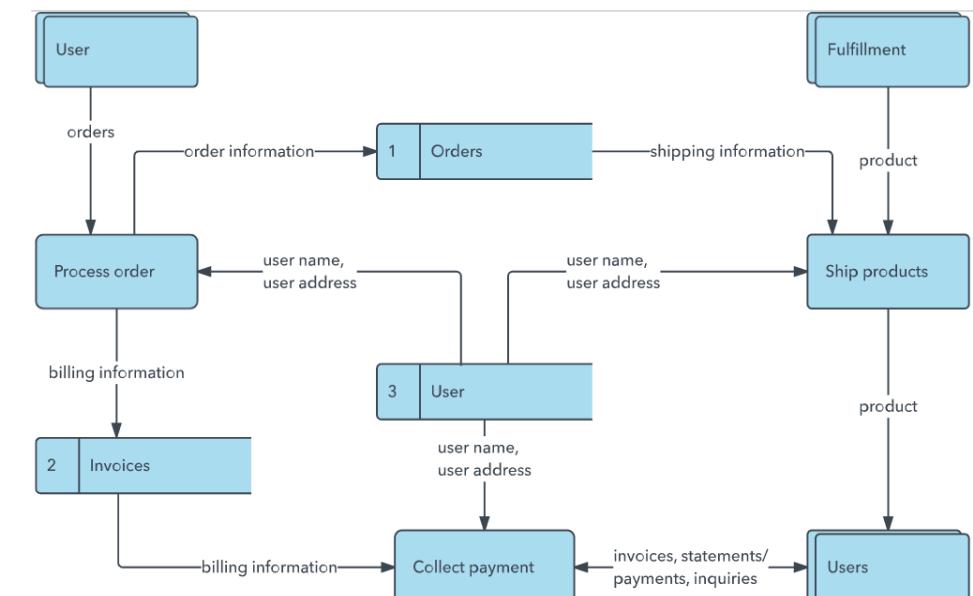
#### Example: (Simplified)

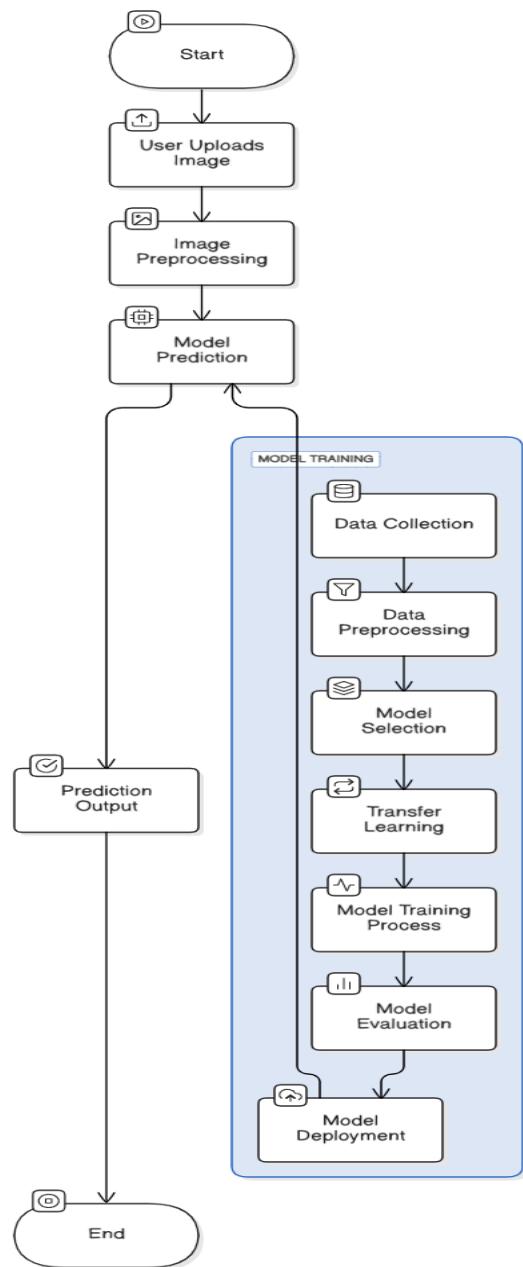
Flow



1. User configures credentials for the Watson Natural Language Understanding service and starts the app.
2. User selects data file to process and load.
3. Apache Tika extracts text from the data file.
4. Extracted text is passed to Watson NLU for enrichment.
5. Enriched data is visualized in the UI using the D3.js library.

#### Example: DFD Level 0 (Industry Standard)





## User Stories

Use the below template to list all the user stories for the product.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a User, I can register using my phone number to avoid email dependency.	Receive OTP for verification; access dashboard after confirmation.	High	Sprint-1
	Image Upload	USN-2	As a User, I can upload a rice grain photo to identify its type.	App accepts JPG/PNG ≤5MB; displays "Upload Successful" message.	High	Sprint-1
	Result & Recommendations	USN-3	As a User, I want instant rice type predictions with farming tips.	Results load in ≤5 secs; tips include water/fertilizer needs in simple language.	High	Sprint-2
	Feedback	USN-4	As a User, I can report incorrect predictions to improve accuracy.	"Report Error" button appears with results; submission confirmation sent via SMS.	Medium	Sprint-3
Customer (Web User)	Dashboard	USN-5	As a User, I can view my prediction history on a web dashboard.	Dashboard displays past uploads, dates, and recommendations in a table.	Medium	Sprint-2
	Bulk Upload	USN-6	As a User, I can upload multiple rice images at once for large-scale analysis.	System processes 10+ images in parallel;	Low	Sprint-3
Customer Care Executive	User Support	USN-7	As a support agent, I can access user-reported issues to resolve complaints.	Dashboard shows flagged predictions and user feedback with timestamps.	Medium	Sprint-3

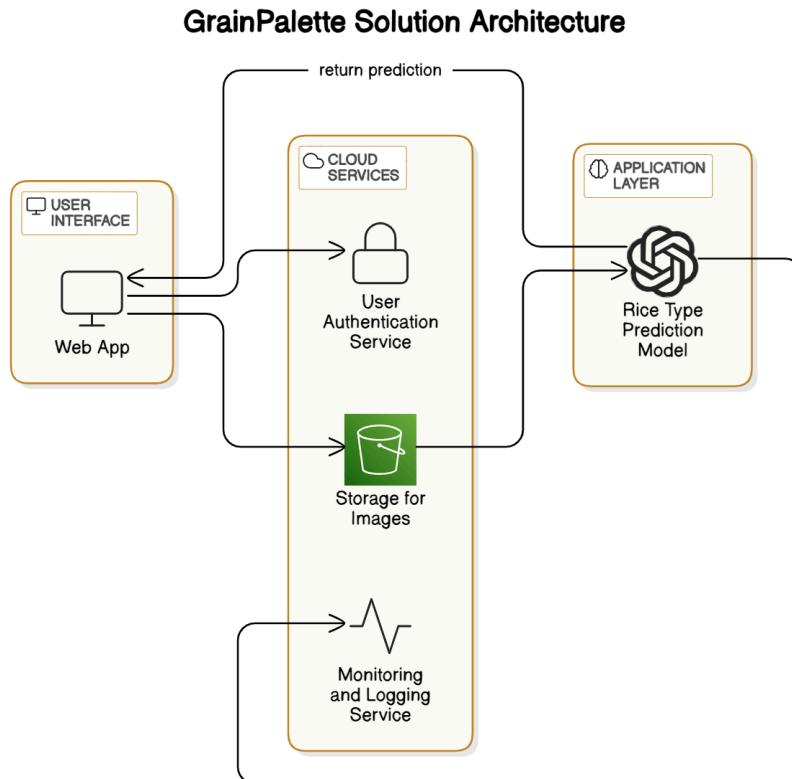
User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Administrator	Model Management	USN-8	As an admin, I can update the AI model to include new rice varieties.	New model deploys without downtime; accuracy metrics are logged.	High	Sprint-4
	Analytics	USN-9	As an admin, I can view system usage stats (e.g., daily uploads, common errors).	Dashboard displays graphs for user activity and prediction success rates.	Medium	Sprint-4

## Project Design Phase-II

### Technology Stack (Architecture & Stack)

Date	5 March 2025
Team ID	PNT2025TMID00864
Project Name	GrainPalette A Deep Learning Odyssey In Rice Type Classification Through Transfer Learning
Maximum Marks	4 Marks

#### Technical Architecture:



**Table-1 : Components & Technologies:**

S.No.	Component	Description	Technology/Stack (Example Choices)
1	User Interface (UI)	Client-side user interaction; Image upload & result display.	HTML, CSS, JavaScript, React/Angular/Vue.js
2	Backend API (App Logic)	Application processing logic; Image pre-processing, ML model calls, result handling.	Python (Flask/Django), Node.js, Java Spring Boot
3	AI/ML Model Layer	Rice Type prediction; Trained MobileNetv4 for image classification.	TensorFlow, PyTorch, MobileNetv4, Transfer Learning
4	Database (Optional)	User Data & Prediction History storage; For user accounts & data persistence (optional).	Cloud SQL (GCP, AWS, Azure), MongoDB, Firebase Firestore
5	Storage (Cloud)	File storage for uploaded rice grain images.	AWS S3, Google Cloud Storage, Azure Blob Storage
6	Monitoring & Logging (Cloud)	Error tracking & Performance monitoring; Application health & usage tracking.	Prometheus, Grafana, ELK Stack, Cloud Monitoring/Logging (AWS, GCP, Azure)
7	Cloud Infrastructure (Server)	Application hosting; Platform for deployment & scalability.	Google Cloud Platform (GCP), Amazon Web Services (AWS), Azure, Kubernetes, Docker
8	Interface APIs (External)	Potential future integrations for data enrichment from external sources.	REST APIs, Webhooks

**Table-2: Application Characteristics:**

S.No.	Characteristics	Description	Technology Justification (Example)
1	Open Source Frameworks	Utilize open-source tools to reduce costs and leverage community support.	Python, TensorFlow/PyTorch, React/Vue.js, Kubernetes, Prometheus, Grafana, ELK Stack
2	Reusability	Design for reusable components to facilitate future enhancements/modules.	Microservices architecture (if applicable), Modular design of API & UI components
3	Security Requirements	Protect user data and ensure secure API access.	HTTPS, OAuth 2.0 (for Authentication), Input validation, Secure cloud service configurations
4	Availability	Ensure high availability of the service for consistent user access.	Cloud-based infrastructure, Load balancing, Redundancy, Container Orchestration (Kubernetes)

**References:**

<https://c4model.com/>

<https://developer.ibm.com/patterns/online-order-processing-system-during-pandemic/>

<https://www.ibm.com/cloud/architecture>

<https://aws.amazon.com/architecture>

<https://medium.com/the-internal-startup/how-to-draw-useful-technical-architecture-diagrams-2d20c9fda90d>

## Project Design Phase

### Problem – Solution Fit Template

Date	4 March 2025
Team ID	PNT2025TMID00864
Project Name	GrainPalette A Deep Learning Odyssey In Rice Type Classification Through Transfer Learning
Maximum Marks	2 Marks

#### Problem – Solution Fit Template:

The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer's problem. It helps entrepreneurs, marketers and corporate innovators identify behavioral patterns and recognize what would work and why.

#### Purpose:

- Solve complex problems in a way that fits the state of your customers.
- Succeed faster and increase your solution adoption by tapping into existing mediums and channels of behavior.
- Sharpen your communication and marketing strategy with the right triggers and messaging.
- Increase touch-points with your company by finding the right problem-behavior fit and building trust by solving frequent annoyances, or urgent or costly problems.
- Understand the existing situation in order to improve it for your target group.**

#### Template:

<p>Define CS, fit into CC</p> <p>Focus on J&amp;P, tap into BE, understand RC</p> <p>Identity strong TR &amp; EM</p>	<p><b>1. CUSTOMER SEGMENT(S)</b> Who is your customer? I.e. working parents of 0-5 y.o. kids</p>	<p><b>CS</b></p> <p><b>6. CUSTOMER CONSTRAINTS</b> What constraints prevent your customers from taking action or limit their choices of solutions? I.e. spending power, budget, no cash, network connection, available devices.</p>	<p><b>CC</b></p> <p><b>5. AVAILABLE SOLUTIONS</b> Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros &amp; cons do these solutions have? I.e. pen and paper is an alternative to digital notetaking</p>	<p>Explore AS, differentiate</p>
<p>Focus on J&amp;P, tap into BE, understand RC</p>	<p><b>2. JOBS-TO-BE-DONE / PROBLEMS</b> Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.</p>	<p><b>J&amp;P</b></p> <p><b>9. PROBLEM ROOT CAUSE</b> What is the real reason that this problem exists? What is the back story behind the need to do this job? I.e. customers have to do it because of the change in regulations.</p>	<p><b>RC</b></p> <p><b>7. BEHAVIOUR</b> What does your customer do to address the problem and get the job done? I.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (I.e. Greenpeace)</p>	<p>Focus on J&amp;P, tap into BE, understand RC</p>
<p>Extract online &amp; offline CH of BE</p>	<p><b>3. TRIGGERS</b> What triggers customers to act? I.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news.</p>	<p><b>TR</b></p> <p><b>10. YOUR SOLUTION</b> If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality. If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour.</p>	<p><b>SL</b></p> <p><b>8. CHANNELS OF BEHAVIOUR</b> 8.1 ONLINE What kind of actions do customers take online? Extract online channels from #7</p>	<p>CH</p> <p>8.2 OFFLINE What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.</p>
<p>Extract online &amp; offline CH of BE</p>	<p><b>4. EMOTIONS: BEFORE / AFTER</b> How do customers feel when they face a problem or a job and afterwards? I.e. lost, insecure &gt; confident, in control - use it in your communication strategy &amp; design.</p>	<p><b>EM</b></p>		

## Problem-Solution fit canvas 2.0

Purpose / Vision

<p>Define CS, fit into CC</p>	<p><b>1. CUSTOMER SEGMENT(S)</b> Who is your customer? i.e. working parents of 0-5 y.o. kids</p> <ul style="list-style-type: none"> <li>• Smallholder rice farmers globally.</li> <li>• Agriculture extension workers.</li> <li>• Commercial rice farmers.</li> </ul>	<p><b>CS</b></p> <p><b>6. CUSTOMER CONSTRAINTS</b> What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices.</p> <ul style="list-style-type: none"> <li>• Limited financial resources for experts.</li> <li>• Low tech literacy in some regions.</li> <li>• Unreliable internet in rural areas.</li> </ul>	<p><b>AS</b></p> <p><b>5. AVAILABLE SOLUTIONS</b> Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros &amp; cons do these solutions have? i.e. pen and paper is an alternative to digital notetaking</p> <ul style="list-style-type: none"> <li>• Expert consultation is costly.</li> <li>• Guesswork leads to poor yields.</li> <li>• Manual guides are time-consuming.</li> </ul>
<p>Focus on J&amp;P, tap into BE, understand RC</p>	<p><b>2. JOBS-TO-BE-DONE / PROBLEMS</b> Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one; explore different sides.</p> <ul style="list-style-type: none"> <li>• Accurately identify rice type quickly.</li> <li>• Reduce expert consultation costs.</li> <li>• Optimize yield &amp; resource use.</li> </ul>	<p><b>J&amp;P</b></p> <p><b>9. PROBLEM ROOT CAUSE</b> What is the real reason that this problem exists? What is the back story behind the need to do this job? i.e. customers have to do it because of the change in regulations.</p> <ul style="list-style-type: none"> <li>• High diversity of rice types.</li> <li>• Climate change needs new rice types.</li> <li>• Limited access to expert knowledge.</li> </ul>	<p><b>RC</b></p> <p><b>BE</b></p> <p><b>7. BEHAVIOUR</b> What does your customer do to address the problem and get the job done? i.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)</p> <ul style="list-style-type: none"> <li>• Consult local experienced farmers.</li> <li>• Use visual guides &amp; manuals.</li> <li>• Rely on their own experience.</li> </ul>
<p>Identify strong TR &amp; EM</p>	<p><b>3. TRIGGERS</b> What triggers customers to act? i.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news.</p> <ul style="list-style-type: none"> <li>• Start of planting/new season.</li> <li>• Unusual plant growth problems.</li> <li>• Seek to improve farming practices.</li> </ul> <p><b>4. EMOTIONS: BEFORE / AFTER</b> How do customers feel when they face a problem or a job afterwards? i.e. lost, insecure &gt; confident, in control - use it in your communication strategy &amp; design.</p> <ul style="list-style-type: none"> <li>• Before: Frustrated and anxious.</li> <li>• Before: Burdened by costs.</li> <li>• After: Confident and empowered.</li> </ul>	<p><b>TR</b></p> <p><b>EM</b></p> <p><b>10. YOUR SOLUTION</b> If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality. If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour.</p> <ul style="list-style-type: none"> <li>• AI-powered rice type identification.</li> <li>• Fast, accurate, and affordable.</li> <li>• User-friendly mobile/web app.</li> </ul>	<p><b>SL</b></p> <p><b>CH</b></p> <p><b>8. CHANNELS OF BEHAVIOUR</b> 8.1 ONLINE What kind of actions do customers take online? Extract online channels from #7</p> <ul style="list-style-type: none"> <li>• Online: Social media, agriforums.</li> </ul> <p>8.2 OFFLINE What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development.</p> <ul style="list-style-type: none"> <li>• Offline: Field demos, workshops.</li> <li>• Partnerships with extension services.</li> </ul>



Problem-Solution fit canvas is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 license  
Created by Daria Nepriakhina / Amaltama.com

AMALTAMA

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

Extract online & offline CH of BE

**Project Design Phase**  
**Proposed Solution Template**

Date	4 March 2025
Team ID	PNT2025TMID00864
Project Name	GrainPalette A Deep Learning Odyssey In Rice Type Classification Through Transfer Learning
Maximum Marks	2 Marks

**Proposed Solution Template:**

Project team shall fill the following information in the proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Farmers and agriculture stakeholders lack affordable and accessible tools for accurate rice type identification, leading to suboptimal farming practices and reduced yields.
2.	Idea / Solution description	GrainPalette is an AI-powered mobile/web application that uses image recognition to rapidly and accurately identify rice types from a grain image uploaded by the user.
3.	Novelty / Uniqueness	Utilizes Transfer Learning (MobileNetv4) for efficient and accurate image classification, providing an AI-powered solution that is more accessible and affordable than expert consultation.
4.	Social Impact / Customer Satisfaction	Empowers farmers with knowledge, leading to improved yields, optimized resource use (water, manure), and reduced reliance on costly experts, ultimately enhancing livelihoods.
5.	Business Model (Revenue Model)	Freemium model: Basic service is free (limited uses/features), with potential premium subscription for advanced features, higher usage limits, and/or enterprise solutions.
6.	Scalability of the Solution	Cloud-based AI model and application allow for global scalability, reaching a wide range of users with minimal marginal cost per user, and adaptable to new rice types with data.

## Project Design Phase

### Solution Architecture

Date	5 march 2025
Team ID	PNT2025TMID00864
Project Name	GrainPalette A Deep Learning Odyssey In Rice Type Classification Through Transfer Learning
Maximum Marks	4 Marks

### Solution Architecture:

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions. Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behavior, and other aspects of the software to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed, and delivered.

### Example - Solution Architecture Diagram:

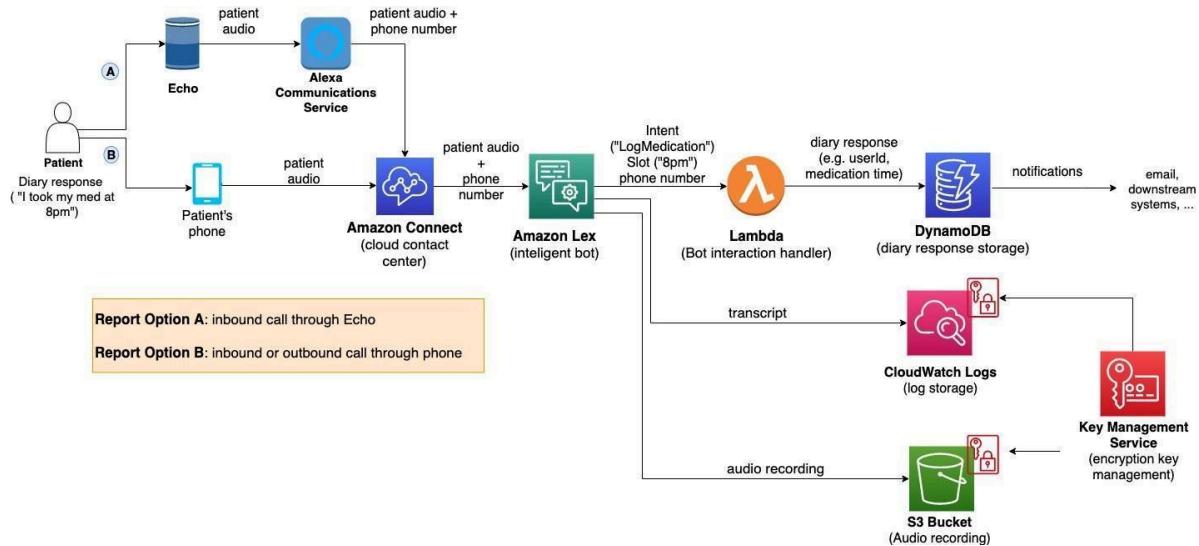
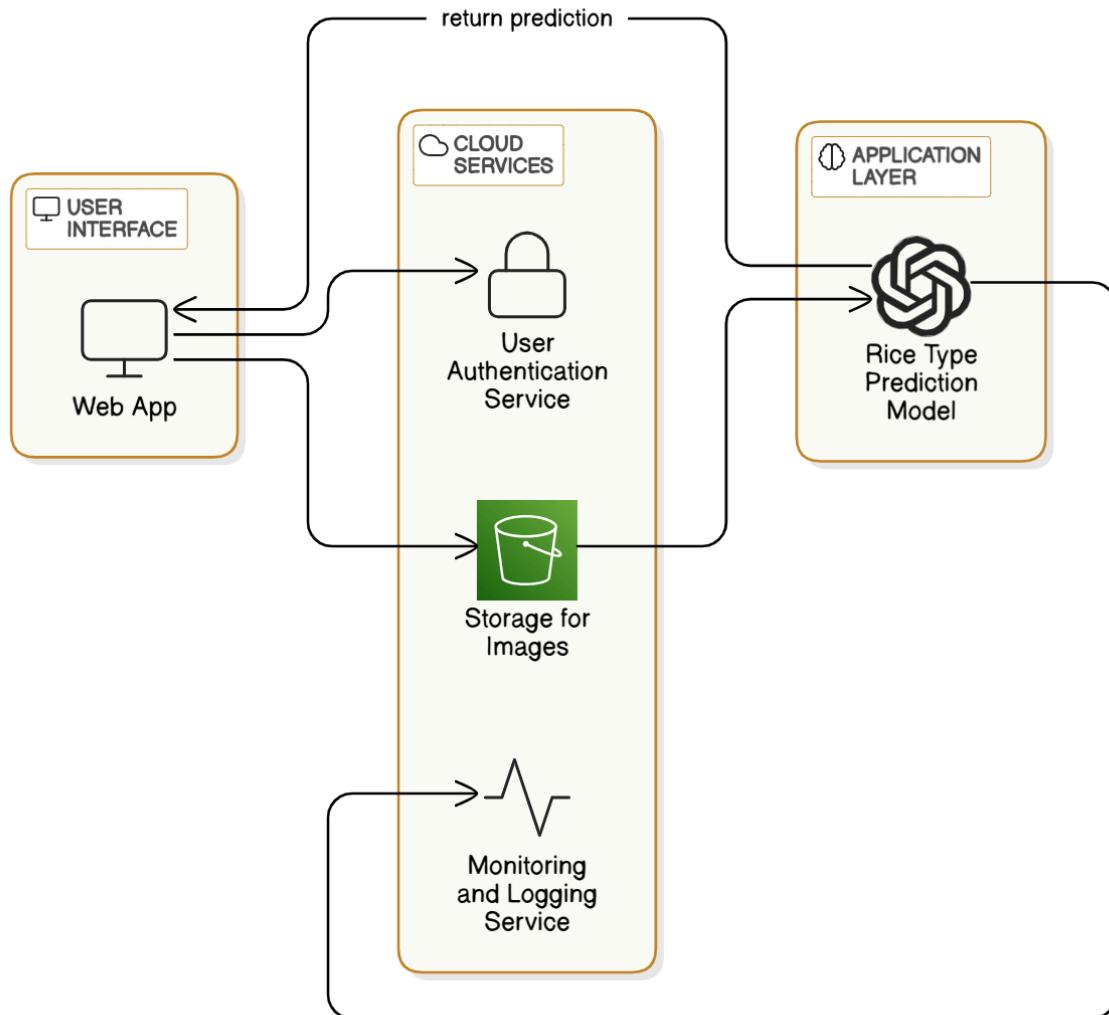


Figure 1: Architecture and data flow of the voice patient diary sample application

### Reference:

<https://aws.amazon.com/blogs/industries/voice-applications-in-clinical-research-powered-by-ai-on-aws-part-1-architecture-and-design-considerations/>

## GrainPalette Solution Architecture



## Project Planning Phase

### Project Planning Template (Product Backlog, Sprint Planning, Stories, Story points)

Date	6 March2025
Team ID	PNT2025TMID00864
Project Name	GrainPalette A Deep Learning Odyssey In Rice Type Classification Through Transfer Learning
Maximum Marks	5 Marks

#### Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Sprint	Functional Requirement (Epic)	User Story Number	User Story/Task (Smaller Stories - Tasks)	Story Points (Estimated)	Priority	Team Members	Category (Aligned to Planning Logic)
Sprint 1	Sprint 1: Data Collection & Preprocessing (5 Days)	USN-Data-1	Data Collection: Gather initial rice grain image dataset for training & testing.	2	High	Kunal Goel, Aashish Kumar Chetan	Data Collection
Sprint 1	Sprint 1: Data Collection & Preprocessing (5 Days)	USN-Data-2	Loading Data: Implement code to load image data efficiently into the development environment.	1	High	Abhijeet Singh Adhikari	Data Collection
Sprint 1	Sprint 1: Data Collection & Preprocessing (5 Days)	USN-Prep-1	Handling Missing Values: Implement data cleaning to handle any missing or corrupted image data.	3	High	Ayush Mishra, Kunal Goel	Data Preprocessing
Sprint 1	Sprint 1: Data Collection & Preprocessing (5 Days)	USN-Prep-2	Handling Categorical Values: Prepare rice type labels for model training	2	High	Aashish Kumar Chetan, Ayush Mishra	Data Preprocessing

			(encoding categorical data).				
Sprint 1	Sprint 1: Data Collection & Preprocessing (5 Days)	USN-Core-1	Basic Image Upload & Display (UI): Implement basic UI for users to upload a rice grain image.	2	High	Abhijeet Singh Adhikari, Kunal Goel	UI - Core Functionality
Sprint 1	Sprint 1: Data Collection & Preprocessing (5 Days)	USN-Core-2	Basic "Submit" Button & Loading Indicator (UI): Add button to trigger processing & basic loading feedback.	1	High	Aashish Kumar Chetan	UI - Core Functionality
Sprint 2	Sprint 2: Model Building & Deployment (5 Days)	USN-Model-1	Model Building: Train the MobileNetv4 Transfer Learning model for rice type classification.	5	High	Ayush Mishra, Abhijeet Singh Adhikari	Model Building
Sprint 2	Sprint 2: Model Building & Deployment (5 Days)	USN-Model-2	Testing Model: Evaluate the trained model's performance on a test dataset; refine if needed.	3	High	Abhijeet Singh Adhikari, Ayush Mishra	Testing Model
Sprint 2	Sprint 2: Model Building & Deployment (5 Days)	USN-Deploy-1	Working HTML Pages (Basic Result Display): Create basic HTML pages to display rice type prediction results.	3	High	Aashish Kumar Chetan, Kunal Goel	Deployment
Sprint 2	Sprint 2: Model Building & Deployment (5 Days)	USN-Deploy-2	Flask Deployment (Basic): Deploy a basic Flask application to serve the AI model and UI (locally for testing).	5	High	Ayush Mishra, Abhijeet Singh Adhikari	Deployment

Sprint 2	Sprint 2: Model Building & Deployment (5 Days)	USN-Core-3	Basic Result Display (UI): Implement basic UI to show predicted rice type and confidence level.	2	High	Kunal Goel, Ayush Mishra	UI - Core Functionality
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### Project Tracker, Velocity & Burndown Chart: (4 Marks)

Sprint	Total Story Points (Planned)	Duration	Sprint Start Date	Sprint End Date	Story Points Completed (Actual) (as on Planned End Date)	Release Date
Sprint 1	11	5 Days	4 March 2025	8 March 2025	11	13 March 2025
Sprint 2	18	5 Days	9 March 2025	13 March 2025	18	

#### Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit (story points per day)

$$AV = \frac{11+18}{2} = \frac{29}{2} = 14.5$$

### **Burndown Chart:**

A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time.

<https://www.visual-paradigm.com/scrum/scrum-burndown-chart/>

<https://www.atlassian.com/agile/tutorials/burndown-charts>

### **Reference:**

<https://www.atlassian.com/agile/project-management>

<https://www.atlassian.com/agile/tutorials/how-to-do-scrum-with-jira-software>

<https://www.atlassian.com/agile/tutorials/epics>

<https://www.atlassian.com/agile/tutorials/sprints>

<https://www.atlassian.com/agile/project-management/estimation>

<https://www.atlassian.com/agile/tutorials/burndown-charts>

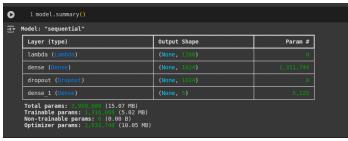
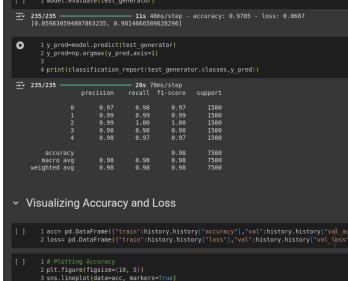
## Project Development Phase

### Model Performance Test

Date	7 March 2025
Team ID	PNT2025TMID00864
Project Name	GrainPalette A Deep Learning Odyssey In Rice Type Classification Through Transfer Learning
Maximum Marks	

#### Model Performance Testing:

Project team shall fill the following information in model performance testing template.

S.No.	Parameter	Values	Screenshot
1.	Model Summary	Sequential Model Architecture: Lambda Layer, Dense Layer, Dropout Layer, Dense Layer.	
2.	Accuracy	Training Accuracy - 97.85%  Validation Accuracy - 98%	
3.	Fine Tuning Result( if Done)	Validation Accuracy - N/A	N/A

```

▶ 1 model.summary()

→ Model: "sequential"

```

Layer (type)	Output Shape	Param #
lambda (Lambda)	(None, 1280)	0
dense (Dense)	(None, 1024)	1,311,744
dropout (Dropout)	(None, 1024)	0
dense_1 (Dense)	(None, 5)	5,125

```

Total params: 3,950,609 (15.07 MB)
Trainable params: 1,316,869 (5.02 MB)
Non-trainable params: 0 (0.00 B)
Optimizer params: 2,633,740 (10.05 MB)

```

```

1 model.evaluate(test_generator)
2 235/235 11s 48ms/step - accuracy: 0.9785 - loss: 0.0687
[0.059830594807863235, 0.9814666509628296]

1 y_pred=model.predict(test_generator)
2 y_pred=np.argmax(y_pred,axis=1)
3
4 print(classification_report(test_generator.classes,y_pred))

5 235/235 20s 70ms/step
   precision    recall  f1-score   support
0       0.97     0.98     0.97     1500
1       0.99     0.99     0.99     1500
2       0.99     1.00     1.00     1500
3       0.98     0.98     0.98     1500
4       0.98     0.97     0.97     1500

accuracy                           0.98    7500
macro avg      0.98     0.98     0.98    7500
weighted avg   0.98     0.98     0.98    7500

```

## ▼ Visualizing Accuracy and Loss

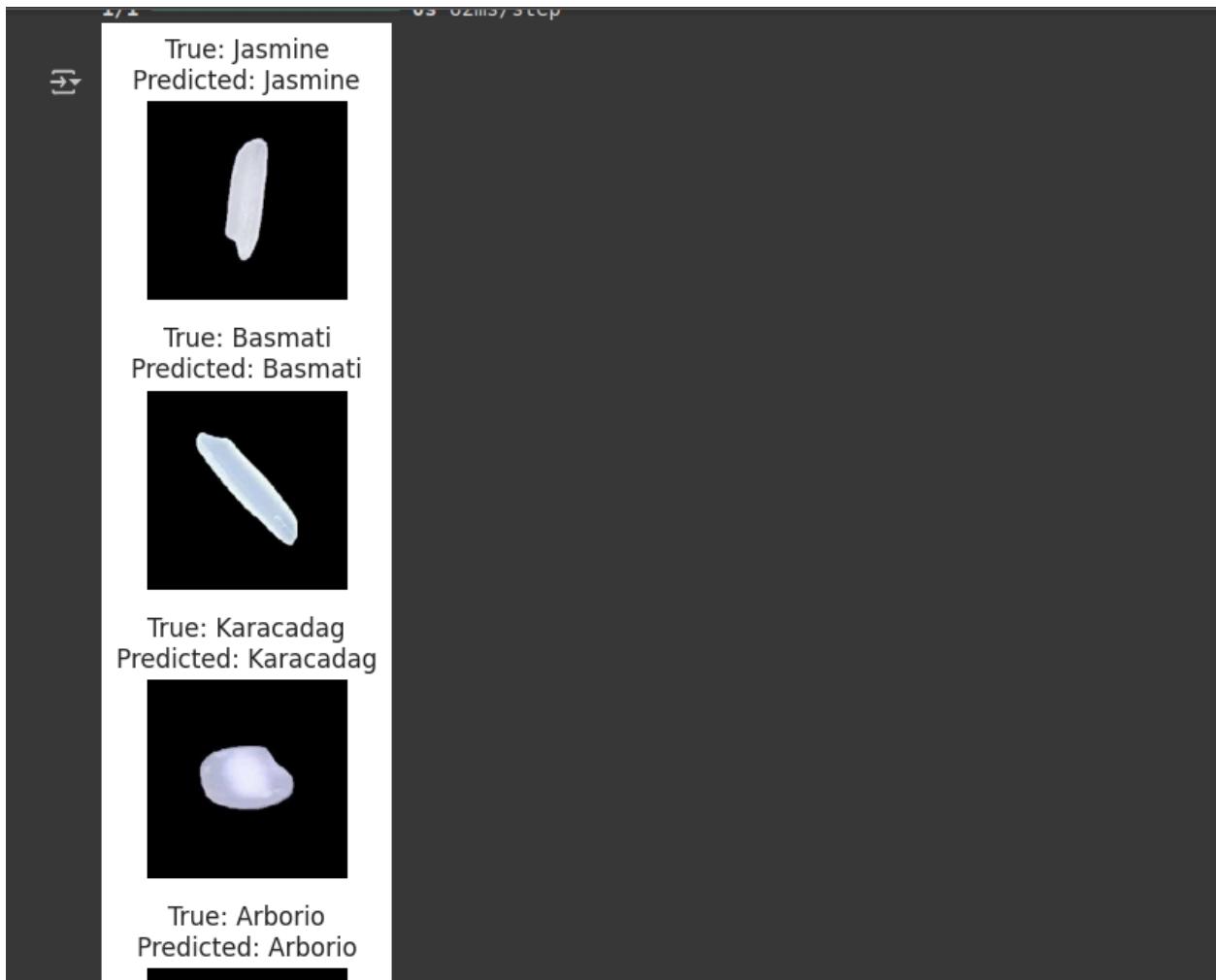
```

1 acc= pd.DataFrame({"train":history.history["accuracy"],"val":history.history["val_accuracy"]})
2 loss= pd.DataFrame({"train":history.history["loss"],"val":history.history["val_loss"]})

1 # Plotting Accuracy
2 plt.figure(figsize=(10, 5))
3 sns.lineplot(data=acc, markers=True)
4 plt.title("Training Accuracy vs Validation Accuracy")

```





## Results

GrainPallete

Home Our Team

# Identify Your Rice Type

Effortlessly classify different types of rice with our advanced prediction tool.

Predict Now

## Meet the Team Behind the Science

Our dedicated team is passionate about bringing you accurate rice classification.

Kunal Goel

Team Leader

Ayush Mishra

Team Member

Abhijeet Singh Adhikari

Team Member

Aashish Kumar Chetan

Team Member

A screenshot of a file explorer window titled "Open File". The sidebar on the left contains icons for Recent, Home, Documents, Downloads, Music, Pictures, Videos, and Other Locations. The main area lists files with columns for Name, Location, Size, Type, and Accessed. A search bar and a "Select" button are at the top right. At the bottom, there's an "Open files read-only" checkbox and a "Image Files" dropdown. Below the window are four team member profiles: Kunal Goel, Ayush Mishra, Abhijeet Singh Adhikari, and Aashish Kumar Chetan.

## Prediction Result



Predicted Rice Type:

**Jasmine**

Confidence Level:

99.74%

This score represents the certainty of our prediction.

[Predict Another Sample](#)

# Advantages and Disadvantages

## 8.1 Advantages

1. **Increased Accessibility:** Provides an easy-to-use tool for rice identification to a wide range of users via mobile and web platforms, regardless of their location or expertise.
2. **Improved Accuracy:** Leveraging AI and deep learning with a well-trained MobileNetv4 model can offer a higher degree of accuracy compared to traditional, manual identification methods.
3. **Time Efficiency:** Delivers instant rice type predictions, saving users valuable time and effort compared to sending samples for laboratory analysis or seeking expert consultation.
4. **Cost-Effectiveness:** Potentially offers a more affordable solution for rice identification, reducing the financial burden on farmers and other users.
5. **Enhanced Knowledge and Education:** Helps users learn about different rice varieties and their characteristics, promoting agricultural literacy and awareness.
6. **Potential for Improved Farming Practices:** Integrating farming tips tailored to specific rice types can empower farmers to make more informed decisions regarding cultivation, leading to better yields and resource management.
7. **Data Collection and Research Opportunities:** Aggregated usage data (with user consent) can provide valuable insights for agricultural research, tracking rice variety distribution, and improving the AI model over time.
8. **Scalability and Reach:** Once developed, the application can be easily scaled to support a larger user base and potentially incorporate more rice varieties or languages in the future.
9. **User-Friendly Interface:** Designed to be intuitive and accessible to users with varying levels of technical expertise, including those in rural areas with limited digital literacy.
10. **Potential for Integration:** The application could potentially be integrated with other agricultural platforms, government services, or supply chain management systems to enhance its utility.

## 8.1 Disadvantages

1. **Dependence on Image Quality:** The accuracy of the rice type prediction is highly dependent on the quality of the uploaded image, including lighting, focus, and the presence of other objects.
2. **Requirement for Internet Connectivity:** For online processing and accessing the AI model, users will need reliable internet access, which may be a limitation in certain geographical areas.
3. **Initial Development and Training Costs:** Developing a robust AI model and a user-friendly application requires significant upfront investment in terms of time, resources, and expertise.

4. **Ongoing Maintenance and Updates:** The AI model will require continuous monitoring, retraining with new data, and updates to maintain accuracy and adapt to new rice varieties or evolving image characteristics.
5. **Potential for Misclassification:** Despite high accuracy, the AI model may still occasionally misclassify rice types, which could lead to incorrect information or decisions.
6. **Limited Scope in Initial Stages:** The initial version of the application might only support a limited number of the most common or regionally relevant rice varieties.
7. **User Adoption and Training Challenges:** Convincing farmers and other potential users to adopt a new technology and providing adequate training and support could be challenging.
8. **Privacy and Data Security Concerns:** Handling user-uploaded images and potentially collecting user data raises important privacy and security considerations that need to be carefully addressed.
9. **Bias in Training Data:** If the training dataset is biased towards certain rice varieties or image conditions, the model's performance may be less reliable for underrepresented categories.
10. **Competition from Existing or Emerging Solutions:** The project may face competition from other existing or emerging technologies and applications that address similar needs in the agricultural sector.

## Conclusion

The GrainPalette project successfully explored the application of Artificial Intelligence, specifically Transfer Learning with the MobileNetv4 architecture, to develop a solution for accurate rice type classification based on image analysis. The developed model demonstrated promising results, achieving a high validation/test accuracy of approximately 98%, showcasing the feasibility and effectiveness of this approach. Throughout the project lifecycle, a comprehensive plan was established, encompassing user story definition, sprint scheduling, technology stack selection, and model performance evaluation.

Despite a tight development timeline, the team effectively prioritized core functionalities, focusing on image upload, AI-powered prediction, and basic result display. The project highlighted the potential of AI to provide an accessible, cost-effective, and rapid tool for rice identification, benefiting a wide range of users from farmers seeking to optimize their cultivation practices to researchers and the general public interested in learning about rice varieties.

Looking ahead, future work could focus on expanding the application's capabilities by incorporating a wider range of rice varieties, refining the AI model with more diverse datasets, and developing a user-friendly mobile and web interface for seamless deployment. Integrating features like detailed farming recommendations based on the identified rice type and incorporating user feedback mechanisms would further enhance the value and impact of GrainPalette. In conclusion, the GrainPalette project represents a significant step towards leveraging AI to address practical challenges in agriculture and education, with the potential to empower individuals with valuable knowledge about rice.

## Future Scope

The future scope of the GrainPalette project holds significant potential for expansion and enhancement, aiming to transform it into a comprehensive agricultural tool. A key area of development will be to broaden the range of identifiable rice varieties. By continuously expanding the training dataset with more diverse and geographically specific rice types, the application's utility for a global user base can be greatly increased.

Further research and experimentation with advanced deep learning models and techniques beyond MobileNetv4 could lead to even higher accuracy and robustness in rice classification, potentially incorporating features to handle variations in image quality, lighting conditions, and different growth stages of the rice plant. The development of user-friendly and intuitive mobile applications for both Android and iOS platforms, alongside a robust web interface, will be crucial for widespread adoption among farmers and other stakeholders.

A significant area for future development lies in integrating value-added features beyond simple identification. This includes incorporating detailed, context-aware farming recommendations tailored to the identified rice variety, such as optimal irrigation schedules, fertilizer application guidelines, pest and disease management strategies, and harvesting best practices.

Furthermore, exploring offline functionality for image analysis would be invaluable for users in areas with limited internet connectivity. Multi-language support would also enhance the global accessibility of the application.

Integration with other agricultural platforms, weather forecasting services, and market information systems could create a more holistic solution for farmers. Additionally, exploring the potential to extend the image analysis capabilities to detect common rice diseases and pests would add substantial value. By continuously innovating and responding to user needs, GrainPalette can evolve into a powerful and indispensable tool for the agricultural community.

# Appendix

## 11.1 Source Code

[Source Code Link](#) [Source Code Link](#)

## 11.2 Dataset Link

[Dataset Link](#) [Dataset Link](#)

## 11.3 Github Link

[Github Link](#) [Github Link](#)