Pollen's Profiling: Automated Classification of Pollen Grains

Team Members:

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Phase 1: Brainstorming & Ideation

Objective:
Analyze challenges in manually identifying and classifying pollen grains under microscopy. Explore how transfer learning and image classification can automate the identification process for environmental, botanical, and medical applications.

- **Key Points :**

1. **ProblemStatement:**
   Manual examination of pollen grains is labor-intensive, subjective, and requires significant expertise. Differences in pollen morphology are subtle and often misclassified by non-experts.
2. **ProposedSolution:**
   "Pollen's Profiling" uses deep learning models like VGG16 or MobileNet to classify microscope images of pollen into their respective categories. Transfer learning improves accuracy even on smaller datasets.
3. **Target Users :**
   - Botanists and palynologists
   - Environmental monitoring agencies
   - Allergy research labs
   - Academic and research institutions
   - Agricultural and crop research centers

4. **ExpectedOutcome:**
   An intelligent application that can classify pollen images quickly and accurately, supporting research, allergy forecasts, and automated laboratory processes.

Phase 2: Requirement Analysis

Objective:

Define the software, hardware, and functional requirements for the pollen classification system. Consider image clarity, dataset diversity, and classification challenges.

- **Key Points:**

5. **Technical Requirements:**
   - Languages: Python 3.10+
   - Frameworks: TensorFlow, Keras
   - Tools: Google Colab, Jupyter Notebook, VS Code
   - Hardware: GPU (NVIDIA recommended), 16 GB RAM
6. **Functional Requirements:**
   - Upload pollen microscope image
   - Classify into specific pollen types
   - Show prediction confidence
   - Display image with label
   - Download result/report (Optional)
7. **Constraints & Challenges:**
   - Similar morphology among different species
   - Varying microscope image quality
   - Imbalanced dataset
   - Need for transparency in classification output for research acceptance

Phase 3: Project Design

Objective:

Design a modular system with easy input-output handling and high interpretability for research professionals.

- **Key Points:**

8. **System Architecture:**
   - Input Module → Image Preprocessing

- Classification Module → Transfer Learning

- Output Module → Display prediction & confidence

9. **User Flow:**

   User uploads image → Preprocessing → Classification → Confidence shown → (Optional: Report Export)

10. **UI/UX Considerations:**

    - Minimal interface suitable for lab settings

    - Color-coded prediction for clarity

    - Mobile and web support

    - Clear feedback for low-quality images

Phase 4: Project Planning (Agile)

Objective:

Follow Agile development with iterative testing, collaboration, and refinement.

- **Key Points:**

11. **Sprint Planning:**

    - Sprint 0: Literature review & dataset sourcing

    - Sprint 1: Data cleaning & augmentation

    - Sprint 2: Model training with base CNN

    - Sprint 3: UI setup

    - Sprint 4: Backend integration

    - Sprint 5: Final testing & enhancements

12. **Task Allocation:**

    - ML Engineer: Model architecture, training

    - Data Engineer: Dataset preparation

    - UI Developer: Interface and display

    - Backend Developer: Integration logic

    - QA Engineer: Accuracy, edge case testing

13. **Timeline & Milestones:**

    - Week 1–2: Dataset finalized

    - Week 3–4: Model training completed

    - Week 5: Frontend-backend integration

    - Week 6: Final validations & testing

Phase 5: Implementation

Objective:

Deploy the model into a working application using a clean tech stack.

- **Key Points:**

14. **Technology Stack:**

    - Frontend: HTML, CSS, Streamlit

    - Backend: Flask API

    - Model: Keras with TensorFlow

    - Deployment: Google Colab / Heroku / Docker

15. **Implementation Steps:**

    1. Collect data (e.g., Kaggle, microscopy datasets)

    2. Preprocess & augment images

    3. Load pre-trained model with custom layers

    4. Train and validate model

    5. Save `.h5` model

    6. Build prediction pipeline

    7. Display classification results

16. **Challenges & Fixes:**

    - Overfitting: Mitigated with data augmentation

    - Similar classes: Improved with fine-tuning

    - Performance: Used MobileNet for optimized speed

Phase 6: Functional & Performance Testing

Objective:

Ensure the model works reliably across microscope images, maintains high precision, and serves its intended scientific purpose.

- **Key Points:**

17. **Tests Performed:**

    - Prediction accuracy per class

    - Image batch testing

    - UI performance and clarity

    - Edge testing: blurred or out-of-focus samples

    - Device/resource usage

18. **Results & Fixes:**

    - Accuracy up to ~90–93% achieved
    - UI bugs resolved
    - Alerts added for uncertain predictions

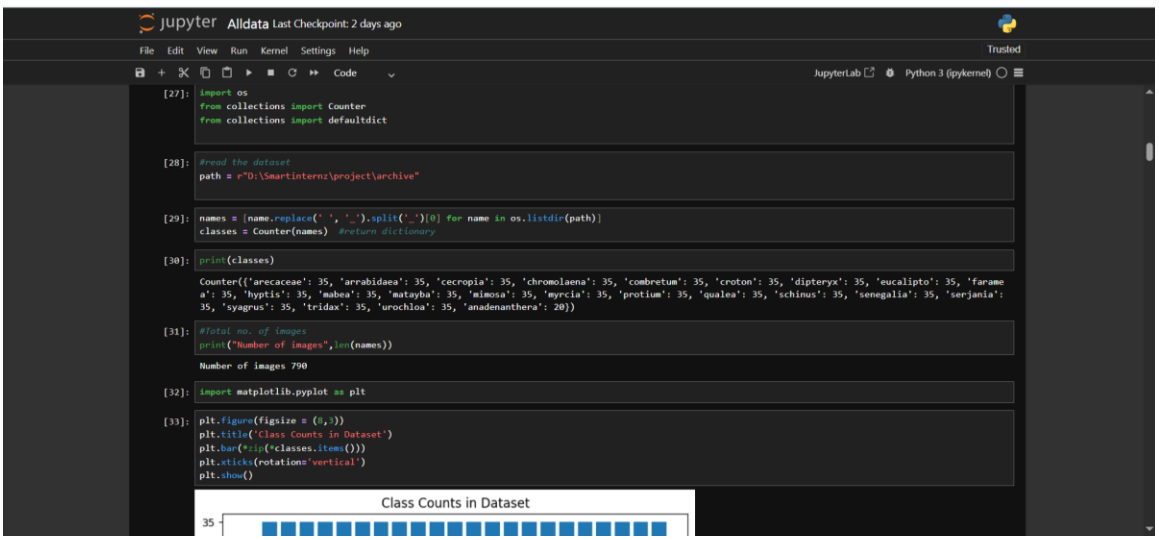
19. **FinalValidation:**

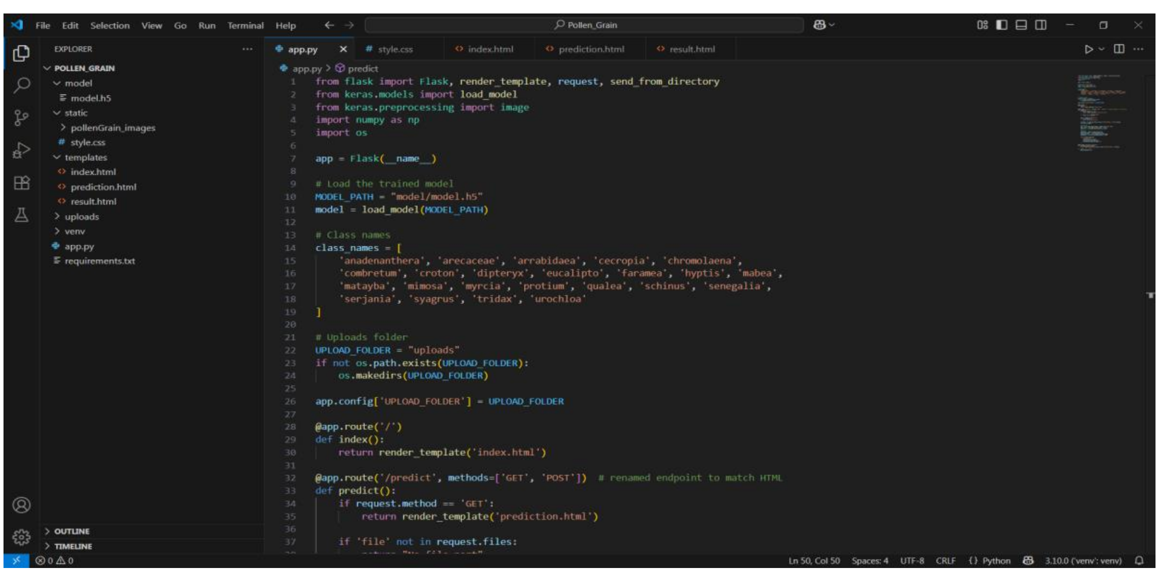
    Model demonstrated strong generalization. Ready for academic demos or lab pilot testing. Supports reproducible research workflows.

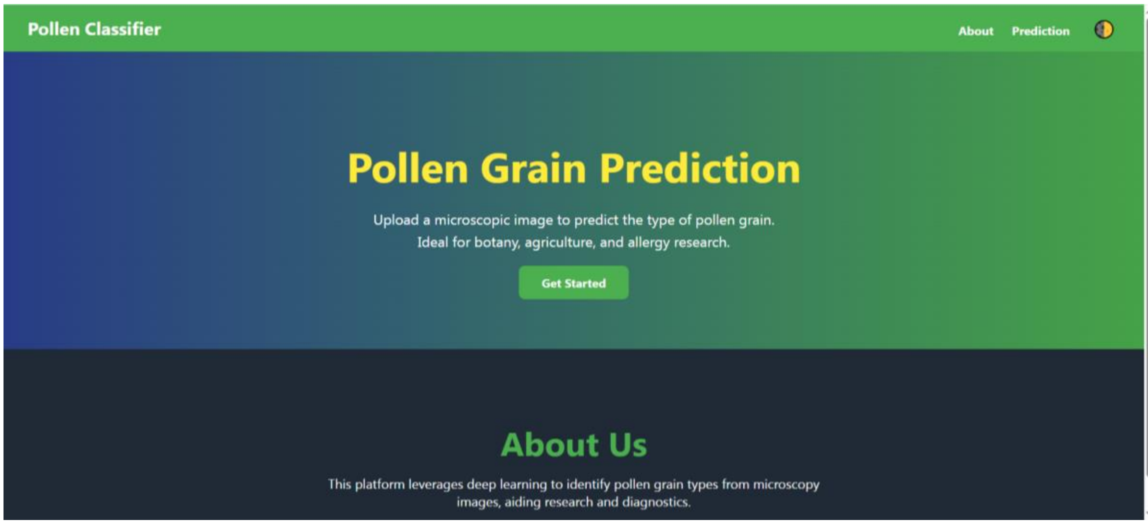
20. **Deployment Options:**

    - Google Colab (Demo)
    - Streamlit + Flask + Heroku (Public tool)
    - Docker container (For offline lab use)

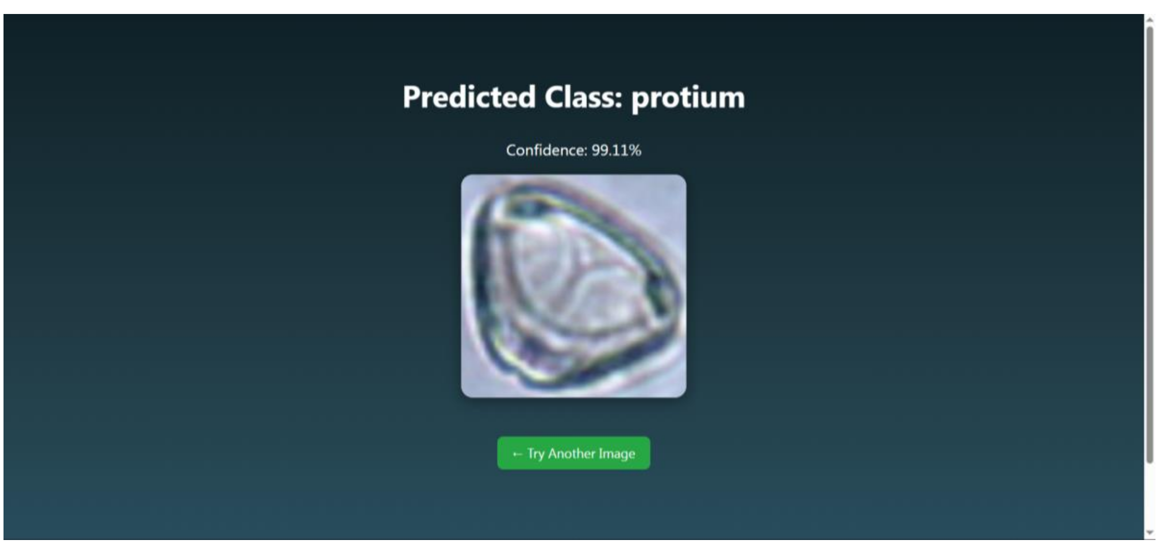
Phase 7: Screenshots and Demo link



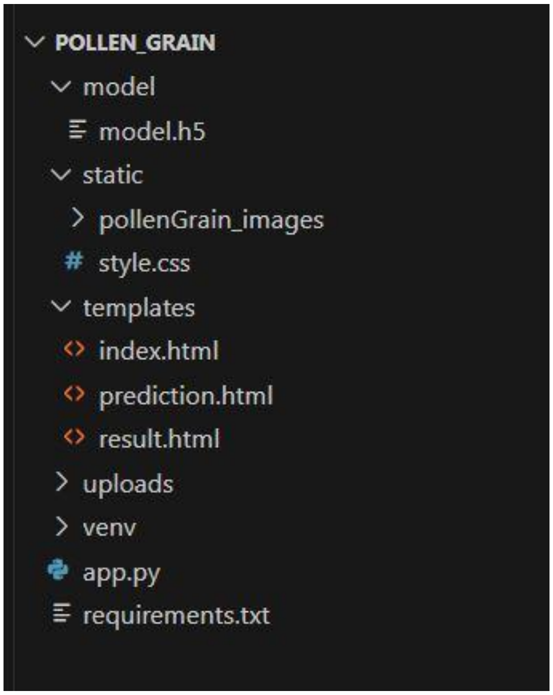


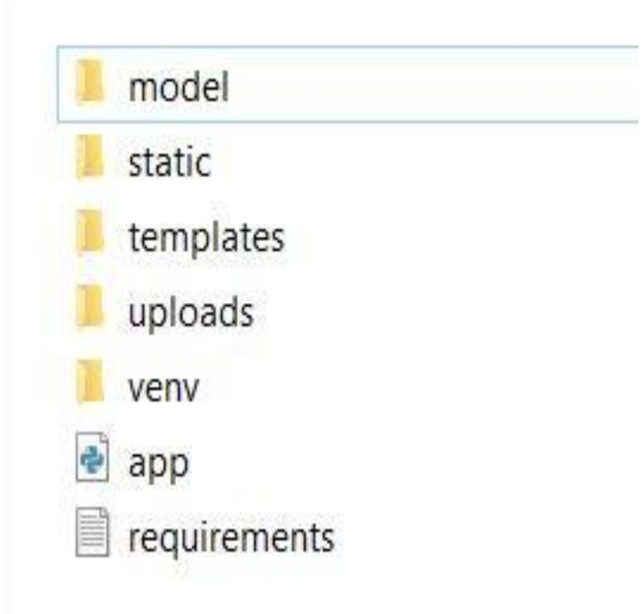

Pollen Classifier
About
Prediction
Pollen Grain Prediction
Upload a microscopic image to predict the type of pollen grain.
Ideal for botany, agriculture, and allergy research.
Get Started
About Us
This platform leverages deep learning to identify pollen grain types from microscopy images, aiding research and diagnostics.


Pollen Classifier
Home
Upload a Pollen Grain Image
Choose File
Predict
Or Try One of These
E. acervulina
E. maxima
E. necatrix
E. tenella


Predicted Class: protium
Confidence: 99.11%
← Try Another Image

Folder Structure :





For Project and Demo video :

https://drive.google.com/drive/folders/1gD_cKVBUwmiR5di4aqjcJxyQUXnez_0o?usp=sharing