

Deployment Report

Students Names:

- Alam Bebar - 207415407
- Ryan Thawkho - 305070567

Executive Summary

This report documents the end-to-end deployment of our hair-loss prediction system. It starts with [User Interface & System Flow](#), which introduces the overall logic of the application and how users interact with the system. This is followed by [Screens & User Journey](#), which details each of the four main screens: the [Loading Screen](#), [Intake Screen \(Core UI\)](#), [Processing Screen](#), and [Results Screen](#). It then moves into [how the app works](#), where the technical backbone is explained, including the [Preprocessing Pipeline](#), [Model Orchestration](#) with our five-model ensemble (ResNet-18, MobileNetV3-Large, EfficientNet-B0, ConvNeXt-Tiny, and DenseNet-121), and the system's [Responsiveness & Robustness](#) features. The report continues with [Deployment Notes](#), which reflect on performance, reliability, and platform considerations, before presenting [Why this UI works](#), which justifies the design choices in terms of usability, clarity, and user trust. Finally, the report concludes with an [appendix of the UI versions](#), documenting the evolution of the interface across versions 1.0–3.0.

Key notes:

- The final version of the system accepts both **image input** and **tabular form input**, which are preprocessed and then used to provide a final classification of the Norwood scale stage and whether the user is experiencing progressing hair loss.
- The **UI connects with 7 models hosted on Hugging Face**: five image models, one tabular model, and one segmentation model for preprocessing.
- The 5 CNN based models with the strongest F1 scores, selected from the 13 tested, are integrated into an **ensemble**, where the final stage is determined through **majority voting**.
- Outputs from the image ensemble and the tabular model are combined to generate **personalized recommendations**, including scientifically backed tips, preventive measures, and an **estimate of hair follicles required for a transplant** as well as a **cost estimate in Israel**.
- Since the **image models were trained on two merged datasets**, which mostly consist of photos taken from **upper front angles**, the system provides its most accurate predictions when images are captured from similar viewpoints.

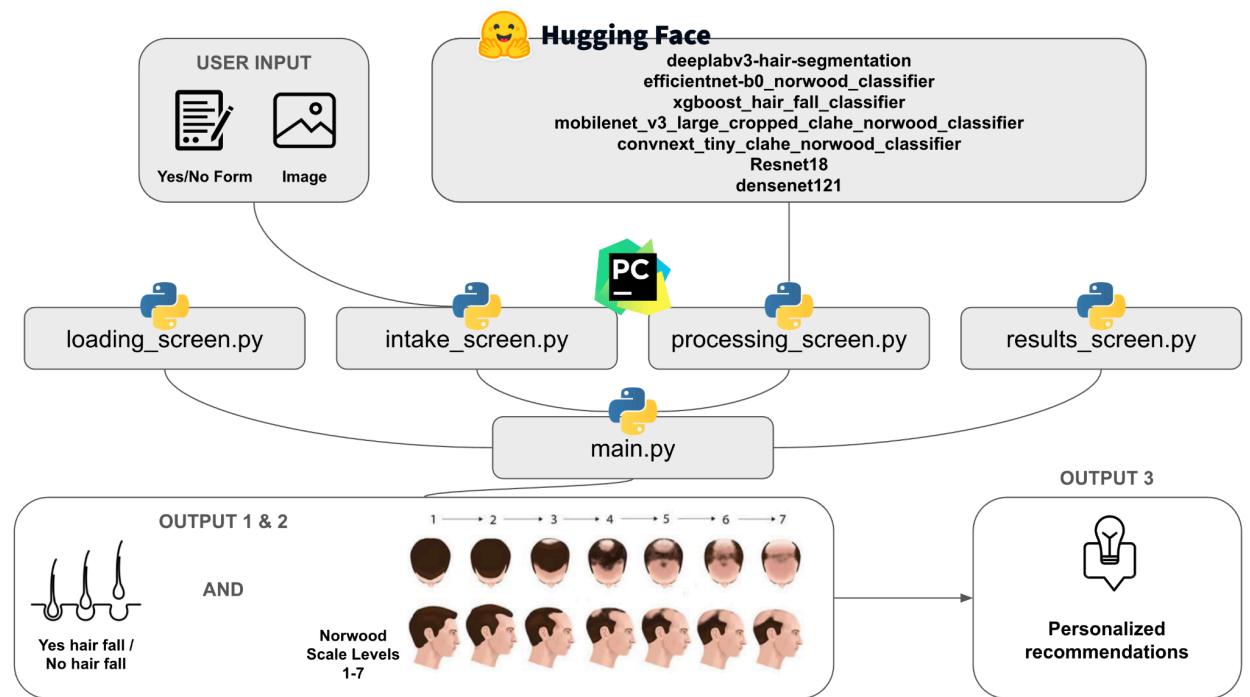
Table of Content

User Interface & System Flow.....	4
Overview.....	4
Screens & User Journey.....	5
1 - Loading Screen.....	5
2 - Intake Screen (Core UI).....	5
3 - Processing Screen (Idle box found within the intake screen).....	5
4 - Results Screen.....	6
How It Works (Under the Hood).....	7
Preprocessing Pipeline.....	7
Model Orchestration.....	7
Responsiveness & Robustness.....	8
Deployment Notes.....	8
Why this UI works.....	9
Appendix: UI Versions.....	10

User Interface & System Flow

Overview

The Hair Loss Predictor is a desktop application built with Tkinter that guides users through a simple, four-screen workflow: **Welcome > Intake & Processing > Results**. The [UI](#) is designed for non-technical users in clinical or consultation settings, while presenting visual previews, model status, and clear recommendations.



Screens & User Journey

1 - Loading Screen

- **Purpose:** Welcome + branding + soft onboarding.
- **What users see:** A welcome headline, short description of the system, a fading logo animation, and a “Start Now” button.
- **What happens under the hood:** No models are loaded here, it’s purely UI polish and navigation to the next step.

2 - Intake Screen (Core UI)

- **Purpose:** Let the user (or clinician) select a **scalp image** and enter **tabular lifestyle factors** (sleep habits, stress, family history, chemicals use, chronic illness, age).
- **Image area:**
 - Shows the **original image** and a **processed preview** side-by-side (See [UI](#))
 - The processed preview is produced by a **fixed preprocessing pipeline**: CLAHE enhancement > hair segmentation (DeepLabV3 w/ ResNet-50 backbone) > tight crop using the hair mask (with 1% expansion to keep context).
 - For transparency, the preview can show a **red boundary overlay** (preview only; not fed to classifiers).
- **Form area:** Comboboxes and an age field capture features in the exact order needed by the XGBoost model.
- **Run button:** Starts model execution in a background thread and opens the Processing screen.

3 - Processing Screen (Idle box found within the intake screen)

- **Purpose:** Keep users informed while heavy work runs.
- **What users see:** A progress bar with animated status (e.g., ‘Loading models...’, ‘Running resnet18...’, ‘Running densenet121...’, etc.) and a thumbnail of the uploaded image.

- **Threading:** All inference happens off the main thread to avoid UI freezes (responsiveness is preserved).

4 - Results Screen

- **Purpose:** Present final predictions and recommendations clearly.
- **Top summary:**
 - Final Norwood level (majority vote across **ResNet-18, MobileNetV3-Large, EfficientNet-B0, ConvNeXt-Tiny, DenseNet-121**).
 - Hair-fall classification (Yes/No) from an **XGBoost** model, with probability (p=) shown when available.
- **Center visuals:**
 - Large level badge (circle) with cleaner typography and layout for instant recognition.
 - Stage reference image.
 - Estimated grafts for the predicted level, calculated based on typical hair density requirements for restoration:
 - **Levels 1-2:** 0-500 grafts (minimal cosmetic need).
 - **Level 3:** ~1,500-2,000 grafts.
 - **Levels 4-5:** ~2,500-3,500 grafts.
 - **Level 6:** ~4,000-5,000 grafts.
 - **Level 7:** 5,500+ grafts.
- **Recommendations:**¹
 - Stage-based guidance (Levels 1-7).
 - Preventive measures explicitly added for Levels 1-5 (e.g., Minoxidil, LLLT, DHT blockers, Ketoconazole 2% shampoo, Tretinoin, Dermarolling with supervision, PRP, nutrition/supplements when deficient, protein intake, avoid smoking, limit alcohol, sleep quality, stress management, monitor genetics).
 - If Hair-fall = Yes and Level ≤ 5 , emphasize monitoring (photos/part-line checks) and integrating the preventive routine.

¹ Educational use only, supported by dermatology literature (e.g., JAAD). Not a substitute for medical advice. Users should consult qualified professionals before starting treatments.

- For Levels 3-5, also suggest hair-transplant consultation if the goal is a full hairline.
- For Levels 6-7, monitoring suggestions are not shown (less relevant for established baldness).

How It Works (Under the Hood)

Preprocessing Pipeline

1. **CLAHE** (OpenCV, LAB-space L-channel; clipLimit=2.0, tileGridSize=8×8) to normalize local contrast.
2. **Segmentation** (DeepLabV3 ResNet-50, weights from Hugging Face) to obtain a hair probability map.
3. **Mask post-processing:** Resize back to original, Otsu threshold, small morphological open/close.
4. **Crop:** Compute bounding box of the hair region and **expand by 1%** of max(w, h) for context; crop the CLAHE image accordingly.
5. **Model input (weights obtained from Hugging Face):**
 - **Image models (5 CNNs)** - ResNet-18, MobileNetV3-Large, EfficientNet-B0, ConvNeXt-Tiny, DenseNet-121 - receive the **cropped-CLAHE** image (with no **red boundary overlay**).
 - **XGBoost** receives the **tabular features** from the Intake form (exact order preserved).

Model Orchestration

- **Lazy loading:** Model weights (Hugging Face for CNNs and joblib for XGBoost) are downloaded on first use.
- **Ensemble:** Each CNN predicts a Norwood level; a **majority vote** produces the final level (ties > lower level chosen deterministically).
- **Calibration note:** Datasets labeled 2-7 are aligned to “Level 2..7”. The code translates model logits into user-facing **Level N** consistently (no off-by-one in the UI).

Responsiveness & Robustness

- **Background threads** prevent UI freezes during downloads/inference.
- **Progress messages** communicate exactly which model is running.
- **Error handling:** Clear message boxes/text area show download or SSL issues (e.g., certificate chain) with suggested fixes (install certifi, set REQUESTS_CA_BUNDLE, retry, etc).

Deployment Notes

- **Deployment plan:** This app **integrates the modeling results into a standalone GUI** that can be used in clinics, labs, or consultation rooms to deliver predictions and guidance directly to end-users.
- **Monitoring & maintenance (what to track):**
 - **Model validity & drift:** Track agreement among the five CNNs and the distribution of predicted levels over time; alert if distributions shift materially (accuracy thresholds / changes).
 - **Feature drift:** Monitor tabular inputs (e.g., age, stress “Yes” rate).
 - **Operational metrics:** Avg. inference time, model download failures, segmentation success rate.
 - **Re-training criteria:** If validation accuracy drops below a set threshold or input data distribution changes, schedule a refresh.
 - **Link reliability:** Nightly job to validate external links (Hugging Face, Google Drive figures, clinic-price page). Auto-fallback to local placeholders if a link fails.
 - **Error handling & telemetry:** Surface clear user-facing messages; capture stack traces to a rotating local log. Anonymize any paths/PII by default.
 - **Documentation:** Keep “Runbook” pages for: downloading weights, regenerating environment, common errors, and how to add/remove an ensemble model.

Why this UI works

- **Clarity:** Two previews (original vs processed crop) build trust and explain “what the model sees.”
- **Guided flow:** Each screen has a single purpose and obvious next action.
- **Actionable output:** Stage-specific and hair-fall-specific guidance, plus a strong medical disclaimer.
- **Extensible:** New models or recommendations can be added without changing the overall UX.

Deployment Report

Appendix: UI Versions

Version name	Screenshot of the UI	Description
		Loading screen - Welcome text misaligned and not indented correctly.
Version 1.0		Intake & Processing screens - Basic photo upload only, with no preprocessing applied. Ran 4 image models (ResNet-18, MobileNet V3 Large, EfficientNet-B0, ConvNeXt-Tiny) plus 1 tabular model (XGBoost). Required manual filling of tabular features for the XGBoost model.

Deployment Report

	<p>THE RESULTS ARE READY!</p> <p>Final Norwood: Level 1 — No hair loss detected ($p=0.45$)</p> <p>(Add assets/norwood1.png)</p> <p>Recommendations (Norwood stage): + Maintain gentle care routine + Baseline photos every 3-6 months</p> <p>Recommendations (Hair loss progression): + Locks stable right now + Keep healthy routine & periodic photos</p> <p>Predicted with report19, incisioner_v1_large, efficientnet_b0, converted_imagenet models and an XGBoost tabular model.</p> <p>LEARN MORE ABOUT US BROWSE OUR MODELS ON HUGGINGFACE COMPARE CLINIC PRICES ></p>	<p>Results screen - Displayed inaccurate predictions due to Hugging Face output formatting (e.g., “Predicted: Level 6 (level=5)” would incorrectly record as 5 instead of 6). Contained only basic recommendations and included buttons without functional links.</p>														
<p>Version 2.0</p>	<p>WELCOME</p> <p>This tool uses image preprocessing (CLAHE, segmentation, cropping), majority-vote Norwood stage classification from four CNNs, and an XGBoost tabular hair-fall predictor. Built with Tkinter, it provides insights for clinical use in hair-transplant settings, with the goal of supporting early intervention and offering personalized recommendations based on the results.</p> <p>We will provide recommendations and scientifically backed preventive measures based on your predicted male pattern, and estimate the number of hair follicles needed to achieve a full hairline</p> <p>START NOW ></p> <p>We are students from The Max Stern Valley College - This is our final project - Students Alm Barbar (207415407), Ryan Thawehko (305070567)</p> <p>Tip: Your hairline is more than just hair — it's confidence, presence, and the best version of you. Don't settle for less.</p>	<p>Loading screen - Welcome text improved with proper indentation and formatting.</p>														
	<p>Run Models</p> <p>Input Image</p> <p>Predictions</p> <p>Done</p> <ul style="list-style-type: none"> - Image Models on PROCESSED (CLAHE + segmentation + 1k crop) - + Norwood: Level 2 + Norwood (majority): Level 2 + EfficientNet_B0: Level 2 + Final Norwood (majority): Level 2 <ul style="list-style-type: none"> - Image Models on CLAHE-ONLY (full hair frame) - + Norwood_v1_Large: Level 2 + EfficientNet_B0: Level 2 + Final Norwood (majority): Level 2 <p>Hair-Fall (XGBoost): No hair fall ($p_{yes}=0.45$)</p> <p>Tabular Features</p> <table border="1"> <tr> <td>Do you stay up late at night?</td> <td>No</td> </tr> <tr> <td>Water in your area a reason?</td> <td>No</td> </tr> <tr> <td>Family hair fall/baldness history?</td> <td>No</td> </tr> <tr> <td>Use chemicals/pig/color?</td> <td>No</td> </tr> <tr> <td>Too much stress?</td> <td>No</td> </tr> <tr> <td>Chronic illness in the past?</td> <td>No</td> </tr> <tr> <td>Age</td> <td>25</td> </tr> </table> <p>Choose Image... /Users/almbarbar/Downloads/hyehye2.v3/folder 2/host/Level 2/Front.jpg rf.Baae7fa9aa6262785db6c208f79bcf.jpg</p> <p>Back View Recommendations → Run Predictions</p>	Do you stay up late at night?	No	Water in your area a reason?	No	Family hair fall/baldness history?	No	Use chemicals/pig/color?	No	Too much stress?	No	Chronic illness in the past?	No	Age	25	<p>Intake & Processing screens - Added a segmentation model from Hugging Face before passing the image to prediction models. Applied cropping with an expansion ratio of 0.01%, followed by a CLAHE filter. Displayed both</p>
Do you stay up late at night?	No															
Water in your area a reason?	No															
Family hair fall/baldness history?	No															
Use chemicals/pig/color?	No															
Too much stress?	No															
Chronic illness in the past?	No															
Age	25															

Deployment Report

		preprocessed and unprocessed images to the user. In idle state, showed model results for the fully processed image (segmentation, CLAHE, crop) and for the CLAHE-only image.
	<p>THE RESULTS ARE READY!</p> <p>Final Norwood: Level 2 — No hair loss detected (p=0.45)</p> <p>Recommendations (Norwood stage)</p> <ul style="list-style-type: none"> - Consider topical minoxidil - Focus on sleep & nutrition - Preventative measures to integrate: <ul style="list-style-type: none"> - Minoxidil - Low-Level Laser Therapy (LLLT) - DHT Blockers (Finasteride or Dutasteride) - Ketoconazole 2% Shampoo - Testosterone therapy - Dermarolling (hair supervision) - Platelet-Rich Plasma (PRP) treatments - Hair-focused supplements (if deficient) - Adequate protein intake - Avoid smoking - Limit alcohol consumption - Improve sleep quality - Stress management - Account for genetic predisposition (family history monitoring) <p>Recommendations (Hair loss progression)</p> <ul style="list-style-type: none"> - Looks stable right now - Keep healthy routine & periodic photos <p>Preprinted with report#18, modelname: v3, large, offsharpened, 3d, convnet, tiny image models and an XGBoost tabular model. These recommendations are for educational purposes only and are supplied by scientists/researchers. They are not a substitute for professional medical advice, diagnosis, or treatment. Always consult your physician or other qualified health provider with any questions you may have regarding a medical condition or treatment. We are not responsible for any outcomes resulting from the use of this information.</p> <p>LEARN MORE ABOUT US BROWSE OUR MODELS ON HUGGINGFACE COMPARE CLINIC PRICES ></p>	<p>Results screen - Updated recommendations for each Norwood level and hair fall status. Improved box alignment and corrected text formatting. Added a cautionary warning message for users.</p>
	<p>WELCOME</p> <p>This tool uses image preprocessing (CLAHE, segmentation, cropping), majority-vote Norwood stage classification from 5 CNNs, and an XGBoost tabular hair-fall predictor. Built with Tkinter, it provides insights for clinical use in hair-transplant settings, with the goal of supporting early intervention and offering personalized recommendations based on the results.</p> <p>We provide recommendations and scientifically-backed preventive measures based on your predicted male-pattern stage, and we estimate the number of hair follicles needed to restore a full hairline.</p> <p>Take a photo from an upper front angle as illustrated</p> <p>START NOW ></p> <p>We are students from The Max Stern Yeshiva College - This is our final project - Students Alon Bebar (207415407), Ryan Thawko (305070567)</p> <p>Tip: Your hairline is more than just hair — it's confidence, presence, and the best version of you. Don't settle for less.</p>	<p>Loading screen - Centered welcome view with a logo scaled ~3x larger, refined and re-wrapped intro copy for clean alignment, and a simple aesthetic glow bar in place of the old spinner (or hidden if unsupported). The “START NOW” button remains prominent below, keeping the layout minimal and balanced for a crisp first impression.</p>

Deployment Report

	<p>Run Models</p> <p>Input Image</p> <p>No image selected</p> <p>(Processed will appear here)</p> <p>Predictions</p> <p>Done.</p> <p>Tabular Features</p> <p>Do you stay up late at night? No</p> <p>Water in your area a reason? No</p> <p>Family hair/fairness history? No</p> <p>Use chemicals/ye/color? No</p> <p>Too much stress? No</p> <p>Chronic illness in the past? No</p> <p>Age 25</p> <p>Choose Image... Back Run Predictions</p>	<p>Intake & Processing screens - The intake screen lets the user upload an image and answer the questionnaire, checks that all inputs are valid, and keeps the “View Recommendations” button hidden until predictions are available. Clear instructions and disabled buttons prevent clicking anything too early, and the screen moves smoothly to processing when ready.</p> <p>The processing screen (idle) shows the uploaded image, displays clear status updates, and runs the prediction in the background without freezing the interface. The “View Recommendations” button only appears once the results are ready, ensuring a smooth and responsive experience.</p>
	<p>Run Models</p> <p>Input Image</p> <p>Done.</p> <ul style="list-style-type: none"> - Image Models on PROCESSED (CLAEFF + segmentation + 1% crop) - <ul style="list-style-type: none"> • mobilenet_v2_Large; Level 2 • convnext_tiny; Level 2 • convnext_tiny; Level 2 • convnext_tiny; Level 2 • final_NeuroNet (majority); Level 2 - Image Models on CLAEFF (full frame) - <ul style="list-style-type: none"> • 1; Level 2 • efficientnet_b0; Level 2 • efficientnet_b0; Level 2 • efficientnet_b0; Level 2 • denseNet121; Level 3 • final_NeuroNet (majority); Level 2 <p>Hair-fall (Xdone): No hair fall! (g_yuv=45)</p> <p>Predictions</p> <p>Tabular Features</p> <p>Do you stay up late at night? No</p> <p>Water in your area a reason? No</p> <p>Family hair/fairness history? No</p> <p>Use chemicals/ye/color? No</p> <p>Too much stress? No</p> <p>Chronic illness in the past? No</p> <p>Age 25</p> <p>Choose Image... /Users/islambabar/Downloads/hyhyte2.v3/folder 2/test/Level 2/1-Front.jpg.rf.Base77af9ae6262705db6c208f79bcf.jpg Back View Recommendations → Run Predictions</p>	

<p>THE RESULTS ARE READY! Final Norwood: Levels 1-2 — No hair loss detected ($p=0.45$)</p> <p>Estimated grafts & price (Israel)</p> <p>Levels 1-2 Estimated grafts: ≈ 800–1,200 grafts DHI/FUE: \$814,000–\$18,000 FUT: \$11,000–\$19,000</p> <p>Estimates only — always consult a clinic. Costs depend on graft count, donor density, hair caliber/curl, previous procedures, and more.</p> <p>Recommendations (Norwood stage)</p> <ul style="list-style-type: none"> Maintain gentle hair routine Baseline photos every 3–6 months Consider topical minoxidil Focus on sleep & nutrition Proven medical measures to integrate: <ul style="list-style-type: none"> • Minoxidil • Low-Level Laser Therapy (LLLT) • DHT Blockers (Finasteride or Dutasteride) • Ketoconazole 2% Shampoo • Testosterone therapy • Demanding (with supervision) • Platelet-Rich Plasma (PRP) treatments • Hair-focusing supplements (if deficient) • Avoid smoking • Limit alcohol consumption • Improve sleep quality • Stress management • Account for genetic predisposition (family history monitoring) <p>Recommendations (Hair loss progression)</p> <p>Looks stable right now Keep healthy routine & periodic photos</p> <p><small>Predicted with comment: Very dense hair! Advanced DHT, moderate hair loss, 3. Large report-3D image model (3D model ensemble) and an XGBoost modular model. These recommendations are for educational purposes only and are supported by scientific research including publications such as the Journal of the American Academy of Dermatology (JAD). They are not a substitute for professional medical advice, diagnosis, or treatment. Always consult a qualified dermatologist or healthcare provider before starting any new treatment or routine. We are not responsible for any outcomes resulting from the use of this information.</small></p> <p style="text-align: center;">BACK START OVER LEARN MORE ABOUT US BROWSE OUR MODELS ON HUGGINGFACE COMPARE CLINIC PRICES ></p>	<p>Results screen - Shows the final Norwood result using grouped labels (1-2, 3, 4-5, 6, 7), unlike recent versions where 1 and 2, and 4 and 5, were shown separately. The stage image loads into a fixed-size box to prevent layout shifts, with a short stage description directly underneath.</p> <p>Recommendations are clearly organized on the right, with separators, and an “Estimated grafts & price (Israel)” panel sits below the level circle with FUE/DHI vs FUT ranges.</p> <p>Navigation buttons (“Back” and “Start Over”) are provided, external links open in the browser, and the legal/notes footer wraps properly so it remains visible on all screen sizes.</p> <p>Norwood scale reference images from Google Drive integrated for each predicted level and displayed accordingly.</p> <p>Buttons [Learn More About Us], [Compare Clinic Prices], and [Browse Our Models on</p>
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Deployment Report

		<p>Hugging Face] linked and tested.</p> <p>Back and Start Over navigation buttons added for improved user flow. Image layout adjusted to maintain stable sizing across varying aspect ratios. Footer and recommendation boxes refined for better visibility and alignment.</p>
--	--	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

