Algorithm Documentation - Seamlessly Integrating a Person into a Scene

Objective:
To place a person into a background scene (sunlit park) in a way that appears photorealistic, by aligning color, lighting, shadows, and positioning - using image editing techniques in Photoshop and analytical support via OpenCV.

Steps Taken:

Task 1: Capturing and Preparing the Person's Image:
1. Captured a front-facing, high-resolution photo of the person against a plain background under neutral lighting.
2. Opened the image in Photoshop.
3. Used the Magic Wand Tool or Quick Selection Tool to select the background.
4. Removed the background by pressing Shift + Delete (Content-Aware Fill or Clear) to isolate the person cleanly.

Task 2: Integrating the Background Scene:
1. Added the new background image by going to File > Place Embedded, selecting the background, and adjusting it using Ctrl + T (Free Transform) to fit the canvas.
2. Ensured that the lighting in the background matched the direction of the original person's photo.

Task 3: Creating and Adjusting Shadow:
1. Selected the layer containing the person (the one without a background).
2. Clicked on the fx (Layer Style) icon at the bottom of the Layers panel.
3. Chose Drop Shadow and adjusted:
    a. Opacity to match shadow intensity.
    b. Angle to match the real light direction from the background.
    c. Distance, Spread, and Size to simulate softness/hardness of the shadow.
4. Converted the Drop Shadow into its own editable layer:
    a. Right-clicked the "Effects" label under the person's layer and selected Create Layer.
    b. This separated the drop shadow into a new layer, allowing precise positioning.
5. Moved and transformed the shadow layer manually using Ctrl + T to align it naturally with the background surface (e.g., path or grass).

Task 4: Coloring and Blending:
1. Missing Steps Identified:
    a. Color harmonization: Ensuring the person's tones matched the warmth and exposure of the background.
    b. Edge blending: Avoiding harsh cut-out edges.

2. Approach Taken:
    a. Used Curves and Brightness/Contrast adjustments clipped to the person's layer to match lighting.
    b. Added a Warming Photo Filter to match the golden-hour sunlight.
    c. Applied a layer mask with a soft round brush at low opacity to feather edges of the person for a seamless look.

Task 5: Shadow and Light Direction Analysis (OpenCV Support):
1. Loaded the background image in Python using OpenCV.
2. Converted it to grayscale and applied histogram equalization and thresholding to detect shadow regions.
3. Cleaned the binary mask and extracted large contours.
4. Fitted ellipses to major shadow regions to estimate shadow orientation.
5. Drew light direction vectors (opposite to shadow) using cv2.arrowedLine, and visualized the result using Matplotlib.

Tools Used & Their Justification:
1. **Photoshop:** Used for all image compositing, shadow creation, and blending because of its intuitive layer system and precise control over lighting and effects.
2. **OpenCV:** Used to programmatically estimate light direction from shadows for better placement and realism.
3. **Matplotlib:** Used to visualize grayscale images, shadow masks, and light/shadow direction overlays for documentation and verification.

Challenges + How I Solved Them:
1. Background removal: Used Photoshop's Magic Wand for efficient, clean cut-outs
2. Shadow realism: Used Drop Shadow + Convert to Layer for full manual shadow control
3. Lighting mismatch: Applied Curves + warming filter to match sunlight tone
4. Harsh edges: Soft feathering via layer masks and brush blending

Possible Enhancements:
1. Use AI-powered relighting tools (e.g., Adobe Neural Filters) for even finer tonal matching.
2. Explore 3D shadow projection techniques for better surface wrapping in complex scenes.