Advanced representation of saliency maps

Bibliotheque

```
import os
import shutil
import numpy as np
from PIL import Image
from typing import Union, Optional

import matplotlib as mplt
import matplotlib.pyplot as plt
from matplotlib import cm
from matplotlib.colors import LinearSegmentedColormap, Colormap

from scipy.ndimage import gaussian_filter
```

Saliency

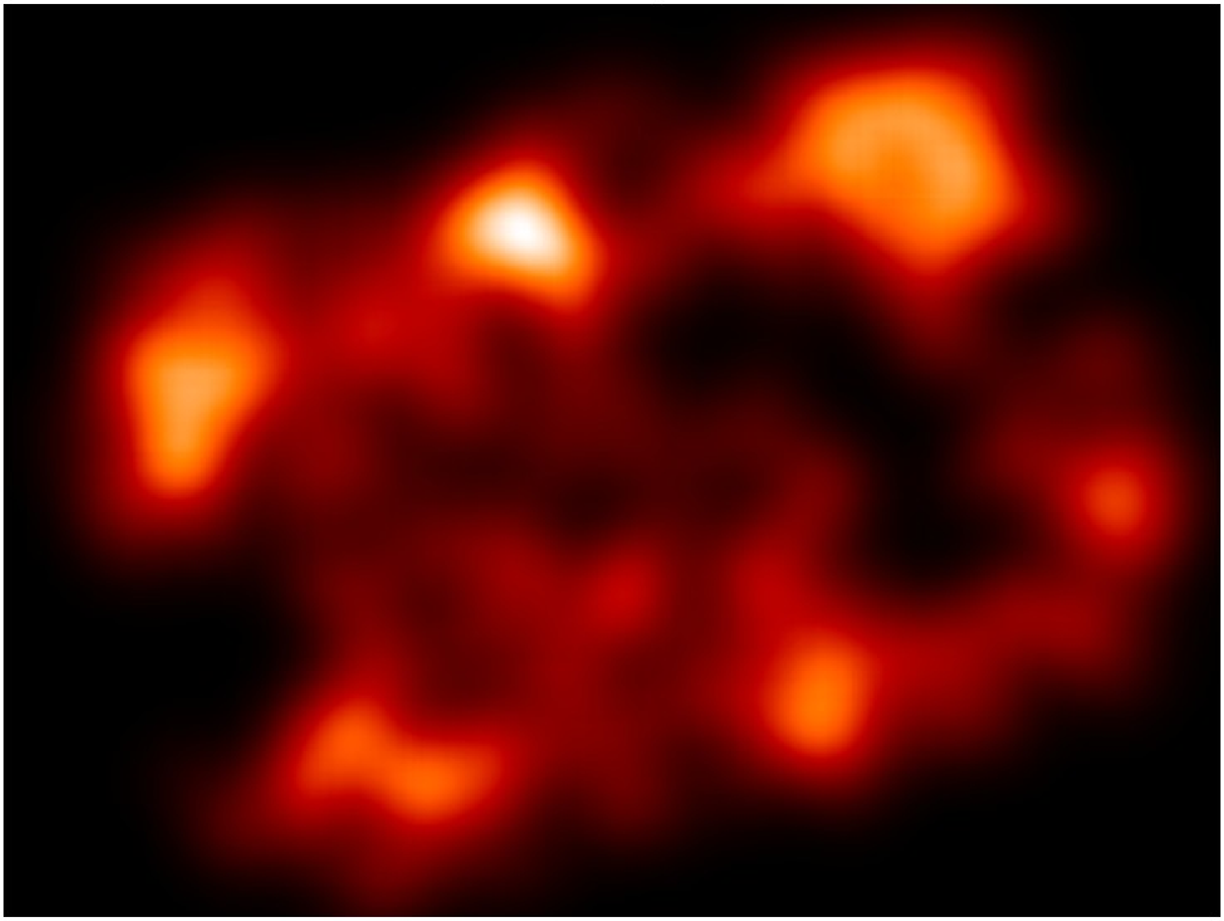
```
class RGBImage:
    def __init__(self, path: str = None, image: Image.Image = None):
        if path:
            self.image = Image.open(path).convert('RGB')
        elif image:
            self.image = image
        else:
            raise ValueError("Either path or image must be provided")

        self.data = np.array(self.image) / 255.0

    @classmethod
    def from_array(cls, array: np.ndarray) -> 'RGBImage':
        image = Image.fromarray((array * 255).astype(np.uint8),
mode='RGB')
        return cls(image=image)

class Saliency:
    def __init__(self, path: str, signed: bool = False):
        rgb_image = RGBImage(path)
        self.data = rgb_image.data


        if signed:
            self.data = (self.data * 2) - 1
        else:
            self.data = self.data
```

```
saliency = Saliency('test_saliency_img.png', signed=False)
image = RGBImage('test.jpg')
cmap= plt.cm.gist_heat
Cmap = Colormap
```

represent_heatmap

```
def represent_heatmap(saliency: Saliency, cmap: Union[None, Cmap] =
None) -> RGBImage:
    saliency_data = np.mean(saliency.data, axis=2)  # Convert to
grayscale

    # Apply the colormap to the saliency data (2D grayscale)
    colored_data = cmap(saliency_data)

    # Convert to RGB format (ignoring the alpha channel if it exists)
    rgb_data = (colored_data[:, :, :3] * 255).astype(np.uint8)
    heatmap_image = Image.fromarray(rgb_data, mode='RGB')

    return RGBImage(image=heatmap_image)

heatmap = represent_heatmap(saliency, cmap=cmap)

# Plotting the results
fig, axes = plt.subplots(1, 1, figsize=(12, 6))

# Show heatmap
axes.imshow(heatmap.image)
axes.set_title("Heatmap")
axes.axis("off")

plt.tight_layout()
plt.show()
```

Heatmap



represent_heatmap_overlaid

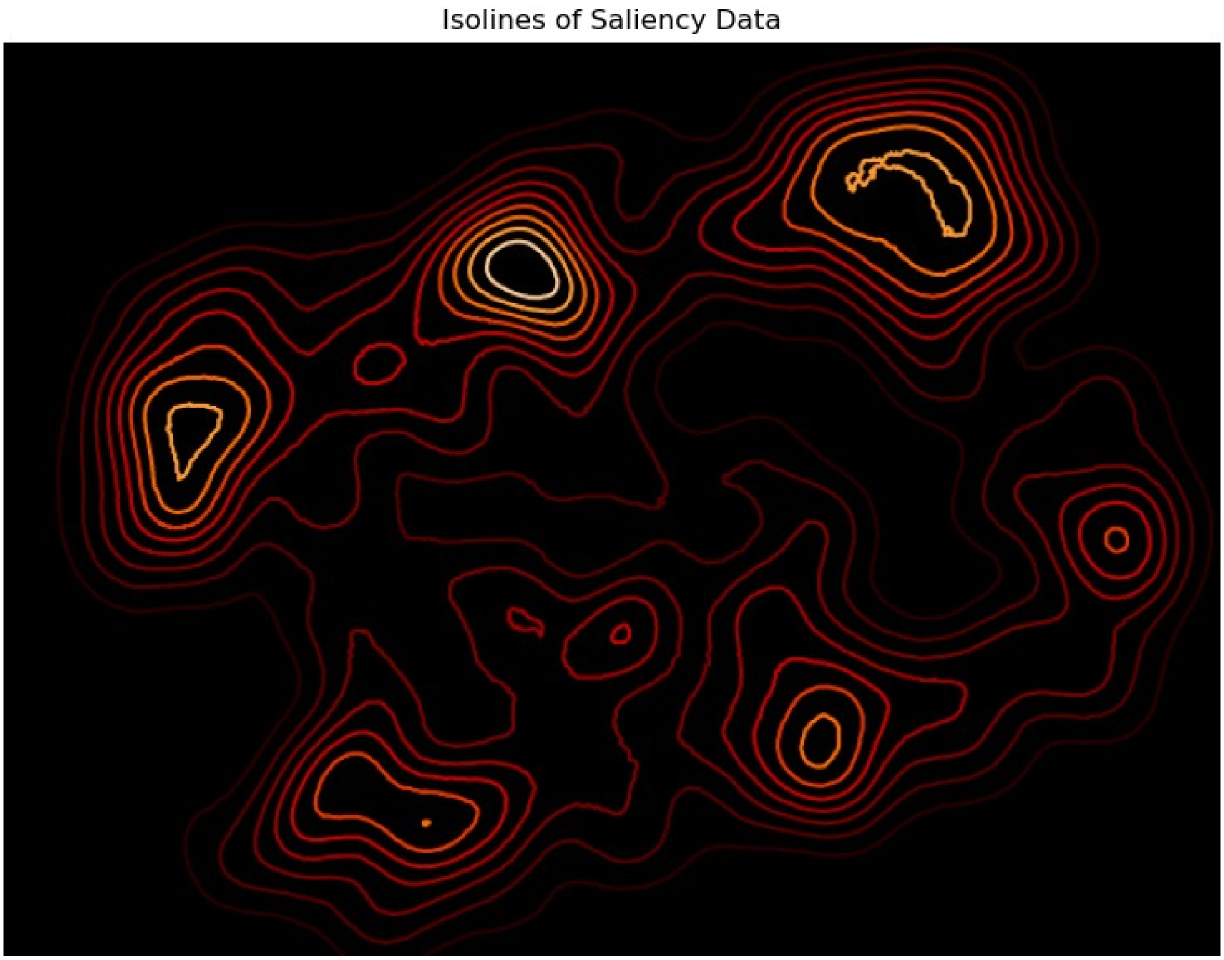
```
def represent_heatmap_overlaid(saliency: Saliency, image: RGBImage,
cmap: Union[None, Cmap]) -> RGBImage:
    alpha = 0.6
    heatmap_image = represent_heatmap(saliency, cmap)

    heatmap_array = np.array(heatmap_image.image)
    image_array = np.array(image.image)

    overlaid_array = np.clip((alpha * heatmap_array + (1 - alpha) *
image_array), 0, 255).astype(np.uint8)

    overlaid_image = Image.fromarray(overlaid_array, mode='RGB')

    return RGBImage(image=overlaid_image)


heatmap = represent_heatmap_overlaid(saliency, image, cmap)

fig, axes = plt.subplots(1, 2, figsize=(12, 6))
```

```python
# Show original image
axes[0].imshow(image.image)
axes[0].set_title("Original Image")
axes[0].axis("off")

# Show heatmap
axes[1].imshow(heatmap.image)
axes[1].set_title("Heatmap")
axes[1].axis("off")

plt.tight_layout()
plt.show()
```

represent_isolines

```python
def represent_isolines(saliency: Saliency, cmap: Union[None, Cmap]) ->
RGBImage:

    saliency_data = np.mean(saliency.data, axis=2)
    fig, ax = plt.subplots(figsize=(saliency_data.shape[1] / 100,
saliency_data.shape[0] / 100))
    fig.patch.set_facecolor('black')
    fig.subplots_adjust(left=0, right=1, top=1, bottom=0)

    # Draw contours based on the saliency data
    contours = ax.contour(saliency_data, levels=11, cmap=cmap)

    ax.axis('off')
    fig.canvas.draw()
    width, height = fig.canvas.get_width_height()
```

```python
    image_array = np.frombuffer(fig.canvas.buffer_rgba(), 
dtype='uint8').reshape(height, width, 4)[:, :, :3]
    image_array = np.flip(image_array, axis=0)

    plt.close(fig)

    # Convert to PIL Image and wrap it in RGBImage
    isoline_image = Image.fromarray(image_array, mode='RGB')

    return RGBImage(image=isoline_image)

isolines = represent_isolines(saliency, cmap)

fig, axes = plt.subplots(1, 1, figsize=(12, 6))

axes.imshow(isolines.image)
axes.set_title("Isolines of Saliency Data")
axes.axis("off")

plt.tight_layout()
plt.show()
```



represent_isolines_superimposed

```
def represent_isolines_superimposed(saliency: Saliency, image:
RGBImage, cmap: Union[None, Cmap]) -> RGBImage:
    alpha = 0.7

    isolines_image = represent_isolines(saliency, cmap)
    isolines_array = np.array(isolines_image.image)
    image_array = np.array(image.image)

    superimposed_array = np.clip((alpha * isolines_array + (1 - alpha)
* image_array), 0, 255).astype(np.uint8)

    superimposed_image = Image.fromarray(superimposed_array,
mode='RGB')

    return RGBImage(image=superimposed_image)

isolines = represent_isolines_superimposed(saliency,image, cmap)
```

```
fig, axes = plt.subplots(1, 1, figsize=(12, 6))

axes.imshow(isolines.image)
axes.set_title("Isolines of Saliency Data")
axes.axis("off")

plt.tight_layout()
plt.show()
```

Isolines of Saliency Data

represent_hard_selection

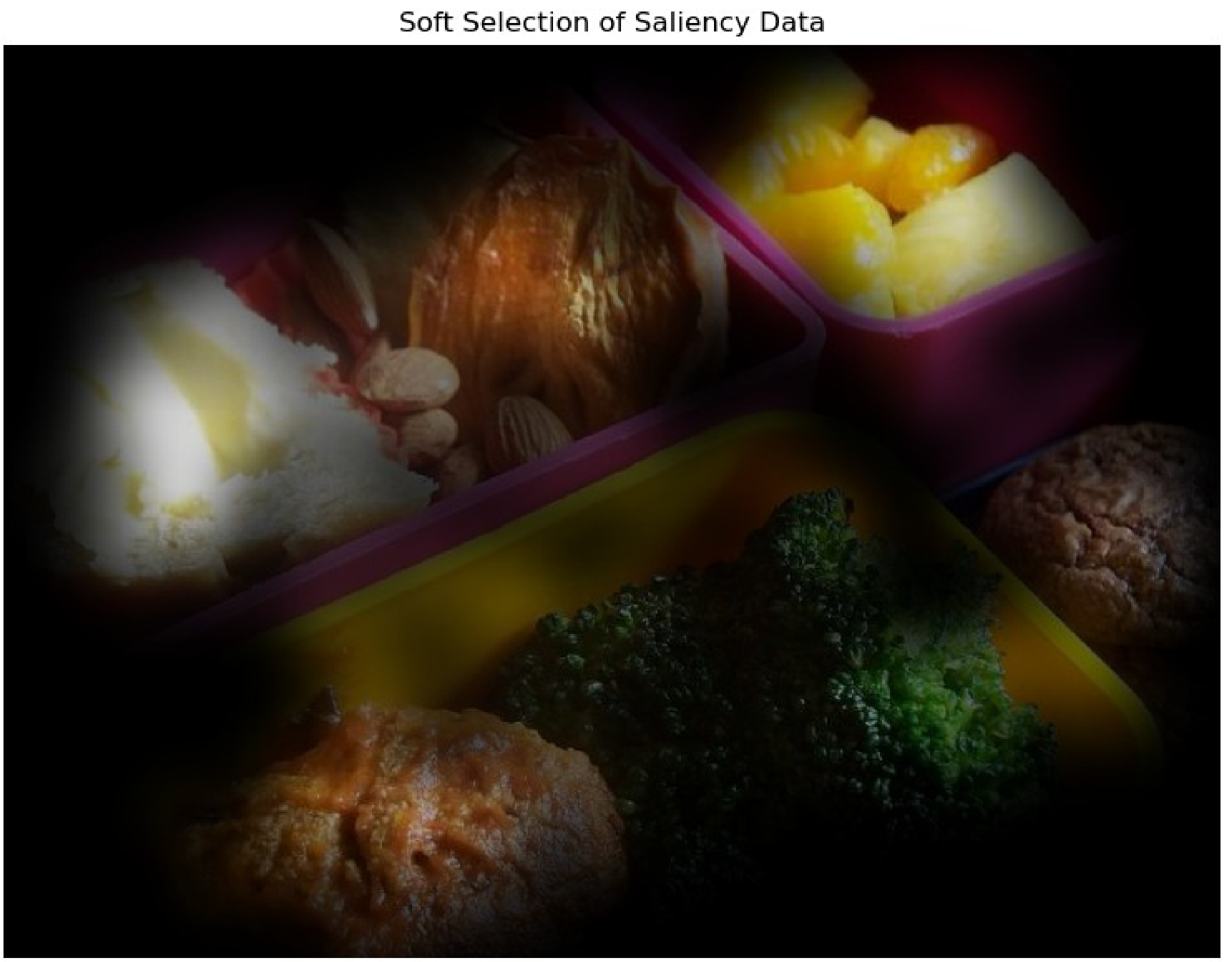
```
def represent_hard_selection(saliency: Saliency, image: RGBImage,
threshold: float) -> RGBImage:
    saliency_data = np.mean(saliency.data, axis=2)
    image_array = np.array(image.image)

    mask = saliency_data >= threshold

    selected_image_array = np.zeros_like(image_array)
    selected_image_array[mask] = image_array[mask]
```

```
    selected_image =
Image.fromarray(selected_image_array.astype(np.uint8), mode='RGB')

    return RGBImage(image=selected_image)

hard = represent_hard_selection(saliency, image, 0.75)

fig, axes = plt.subplots(1, 1, figsize=(12, 6))

axes.imshow(hard.image)
axes.set_title("Isolines of Saliency Data")
axes.axis("off")

plt.tight_layout()
plt.show()
```

Isolines of Saliency Data

represent_soft_selection

```
def represent_soft_selection(saliency: Saliency, image: RGBImage,
threshold: float) -> RGBImage:
    # Convertir les données de saliency et d'image en tableaux NumPy
    saliency_data = np.array(saliency.data)
    image_array = np.array(image.image)


    soft_selection_array = image_array * saliency_data

    soft_selection_image =
Image.fromarray(soft_selection_array.astype(np.uint8), mode='RGB')

    return RGBImage(image=soft_selection_image)

soft = represent_soft_selection(saliency, image, 0)

fig, axes = plt.subplots(1, 1, figsize=(12, 6))

axes.imshow(soft.image)
axes.set_title("Soft Selection of Saliency Data")
axes.axis("off")

plt.tight_layout()
plt.show()
```



Comparaison

```
def plot_comparison(results, titles, max_cols=4):
    total_images = len(results)
    rows = (total_images + max_cols - 1) // max_cols

    fig, axes = plt.subplots(rows, max_cols, figsize=(15, 5 * rows))
    axes = axes.flatten()

    for i in range(total_images):
        axes[i].imshow(results[i].image)
        axes[i].set_title(titles[i])
        axes[i].axis('off')

    for j in range(total_images, len(axes)):
        axes[j].axis('off')

    plt.tight_layout()
    plt.show()
```

```
def grid_comparison(images_path, saliency_path, threshold=0.75,
cmap=plt.cm.gist_heat):
    saliency = Saliency(saliency_path, signed=False)
    image = RGBImage(images_path)

    titles = ["Image Original", "Heatmap", "Heatmap Overlaid",
"Isoline", "Isoline Overlaid", "Hard Selection", "Soft Selection"]

    # Apply different methods
    list_img = []
    list_img.append(image)
    list_img.append(represent_heatmap(saliency, cmap=cmap))
    list_img.append(represent_heatmap_overlaid(saliency, image,
cmap=cmap))
    list_img.append(represent_isolines(saliency, cmap=cmap))
    list_img.append( represent_isolines_superimposed(saliency, image,
cmap=cmap) )
    list_img.append(represent_hard_selection(saliency, image,
threshold))
    #for i in np.arange(0.4, 0.9, 0.1):
    #    list_img.append(represent_hard_selection(saliency, image, i))
    #    titles.append(titles[5] + str(round(i, 2)))

    list_img.append(represent_soft_selection(saliency, image,
threshold))

    plot_comparison(list_img, titles)


def LoadData(directoryImage, directorySaliency, ImageNumber):
    for filename in os.listdir(directoryImage):
        if ImageNumber>0:
            saliency_path =  os.path.join(directorySaliency,filename)
            images_path = os.path.join(directoryImage,filename)
            grid_comparison(images_path, saliency_path)

            ImageNumber-=1
        else:
            break

saliency_dir = './../MexCulture142/saliency'
total_images_dir = './../MexCulture142/ImageTotal'
X = LoadData(total_images_dir,saliency_dir, 5)
```

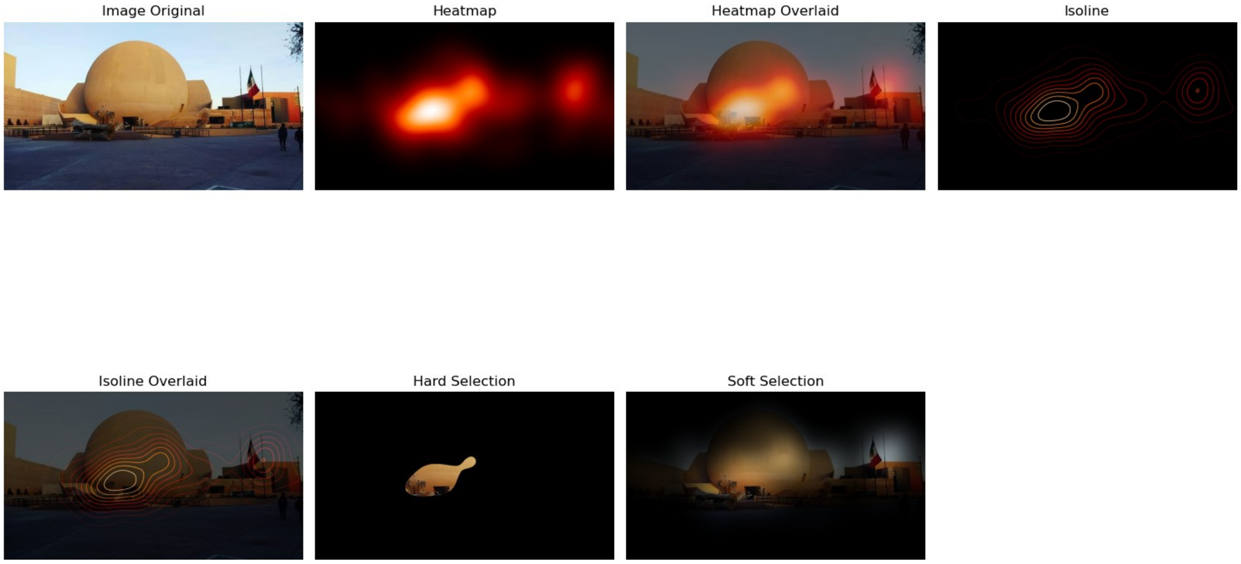


Image Original
Heatmap
Heatmap Overlaid
Isoline
Isoline Overlaid
Hard Selection
Soft Selection

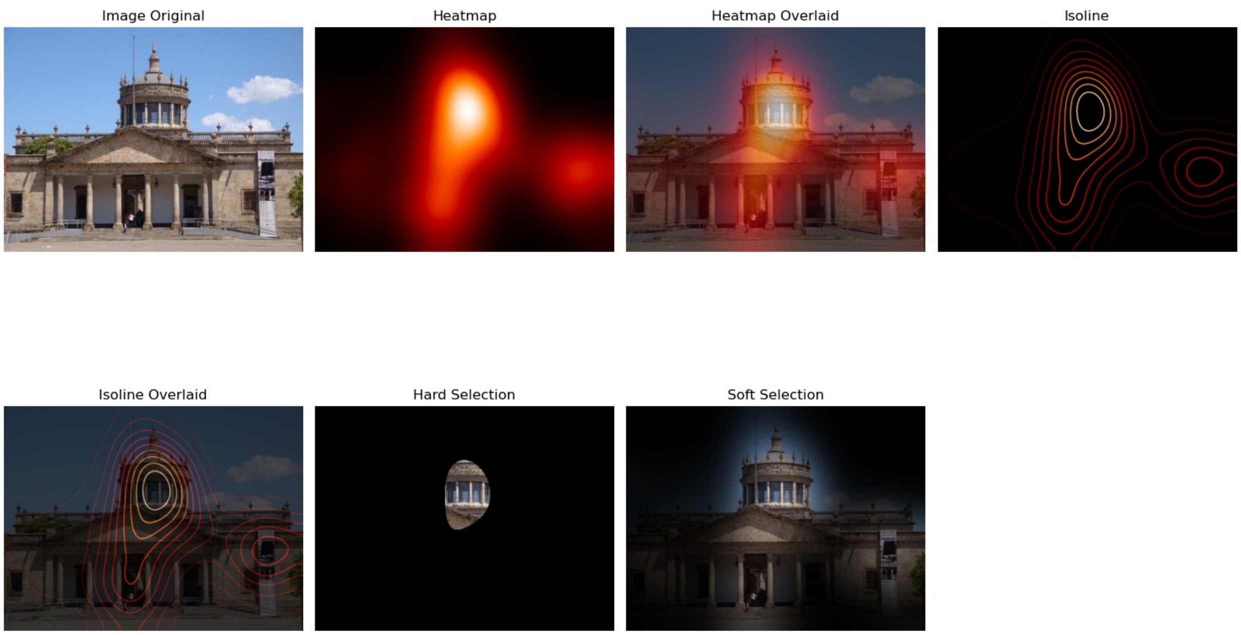


Image Original
Heatmap
Heatmap Overlaid
Isoline
Isoline Overlaid
Hard Selection
Soft Selection

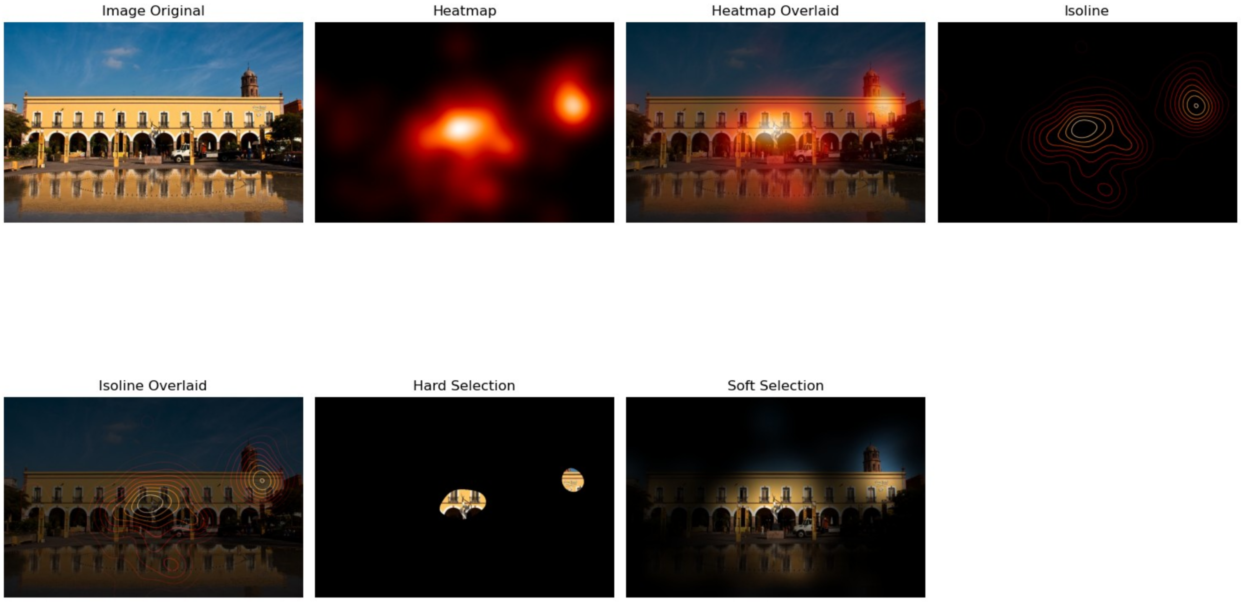


Image Original
Heatmap
Heatmap Overlaid
Isoline
Isoline Overlaid
Hard Selection
Soft Selection

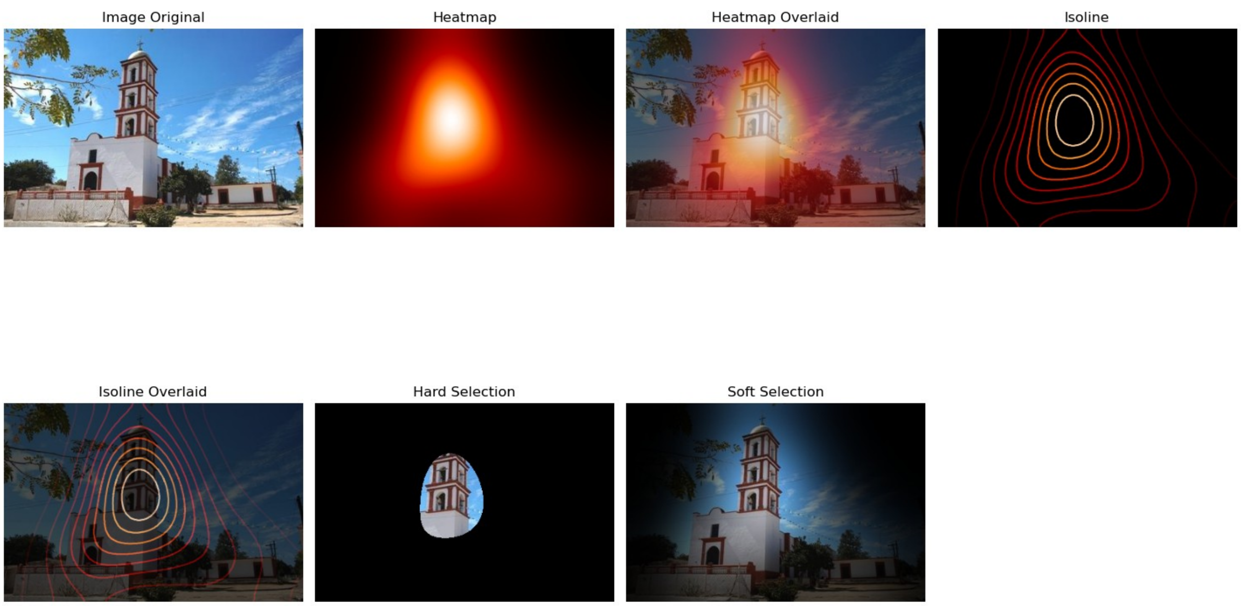


Image Original
Heatmap
Heatmap Overlaid
Isoline
Isoline Overlaid
Hard Selection
Soft Selection

Comparaison des approches

- Les heatmaps offrent une visualisation claire à comprendre. Les points importants sont facilement mis en avant, ce qui peut se faire au détriment de la vision de l'image.
- Les isolines permettent une analyse précise des variations. On voit bien les détails mais il n'est pas facile à l'interpréter.
- Les sélections (hard et soft) offrent un compromis de lisibilité et restent très simples à comprendre.

Approche gagnante

Je n'ai pas l'impression qu'il existe une approche universellement meilleure. Suivant les objectifs, l'une peut se distinguer des autres :

- La heatmap superposée -> pour son intuitivité
- Les isolines superposées ou la soft selection -> pour l'analyse détaillée