Patch Extraction 3.0

July 6, 2025

Sat Jul 5th 2025, Jakob Balkovec

1 Patch Extraction (FGADR Seg-set) Continued (Resolving Multiple Labels)


```
{
  "Total_Images": 1,842,
  "Lesion_Masks_Pixel_Level_Annotations": [
    "Microaneurysms_Masks",
    "Hemorrhages_Masks",
    "HardExudate_Masks",
    "SoftExudate_Masks",
    "IRMA_Masks",
    "Neovascularization_Masks"
  ],
  "Original_Images_Directory": "Original_Images"
}
```


Exceptional Candidates: `0068_1.png`, `0058_1.png`, `0031_2.png`

[ ]:
```python
from pathlib import Path

import cv2

from tqdm import tqdm

import matplotlib.pyplot as plt
import matplotlib.colors as mcolors
import matplotlib.patches as mtpltlib_patches
from matplotlib.patches import Polygon as MplPolygon

import numpy as np
import pandas as pd

from shapely.geometry import Polygon
from shapely.geometry.base import BaseGeometry
from shapely.affinity import scale, translate
```

```
from descartes import PolygonPatch

from skimage import measure

# this is to filter "shapely's" warning abt some intersection stuff...
#   I tried debugging it but gave up...if this casues more issues down the road,
#   I'll put more effort into fixing it
#
# FIXED: (sort of) -> found out it;s because the healthy patches don't have a␣
↪shape...
import warnings
warnings.filterwarnings("ignore", message=".*invalid value encountered in␣
↪simplify_preserve_topology.*")
warnings.filterwarnings("ignore", message=".*invalid value encountered in␣
↪intersection.*")
warnings.filterwarnings("ignore", message=".*invalid value encountered in␣
↪intersects.*")
```

1.1 Configuration

[ ]:
```
base_path = Path.cwd()
mask_root = base_path.parent / 'data' / 'Seg-set'
csv_out_path = base_path.parent / 'data' / 'csv'

IMAGE_PATH = base_path.parent / 'data' / 'Seg-set' / 'Original_Images'
CSV_FILE = base_path.parent / 'data' / 'Seg-set' / 'DR_Seg_Grading_Label.csv'

MASKS_DIRS = {
    'microaneurysms': 'Microaneurysms_Masks',
    'hemorrhages': 'Hemorrhage_Masks',
    'hard_exudates': 'HardExudate_Masks',
    'soft_exudates': 'SoftExudate_Masks',
    'irma': 'IRMA_Masks',
    'neovascularization': 'Neovascularization_Masks'
}

COLOR_MAP = {
    'hemorrhages': ('blue', 0.3),
    'microaneurysms': ('red', 0.3),
    'hard_exudates': ('green', 0.3),
    'soft_exudates': ('orange', 0.3),
    'irma': ('purple', 0.3),
    'neovascularization': ('cyan', 0.3),
}

TICK_COLOR_MAP = {
    'hemorrhages': 'white',
```

```
    'microaneurysms': 'yellow',
    'hard_exudates': 'black',
    'soft_exudates': 'blue',
    'irma': 'white',
    'neovascularization': 'black',
}

# cache
cached_paths = []
```

1.2 Utility Functions

[ ]:
```
def load_green_clahe_image(image_path, clip_limit=2.0, tile_grid_size=(8, 8))␣
↪-> np.ndarray:
    # pre: image_path is a valid path to an image file
    # post: CLAHE enhanced green channel image
    # desc: loads an image and applies CLAHE to the green channel.

    image = cv2.imread(str(image_path))
    image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

    green = image[:, :, 1]
    clahe = cv2.createCLAHE(clipLimit=clip_limit, tileGridSize=tile_grid_size)
    enhanced_green = clahe.apply(green)

    return enhanced_green

def load_original_image(image_path) -> np.ndarray:
    # pre: image_path is a valid path to an image file
    # post: returns the loaded image as a numpy array
    # desc: loads an image from the specified path

    return cv2.imread(str(image_path))

def extract_patches_with_metadata(image, patch_size, source_img_name,␣
↪skip_non_full_patches=False):
    # pre: image is a NumPy array; patch_size is int > 0; source_img_name is str
    # post: returns a list of dicts, each describing a patch and its metadata
    # desc: slices image into non-overlapping patches and attaches spatial/
↪traceability info

    # note: if skip_non_full_patches is True, it skips patches that do not fit␣
↪the full patch size
    #  -> mostly patches along the edges that are something like 25 x 20
    #       -> I say mostly because I haven't tested this thoroughly
    #          with all possible patch sizes, just noticed 4 cases
```

```
    height, width = image.shape[:2]
    patches = []

    for y in range(0, height, patch_size):
        for x in range(0, width, patch_size):
            x1, y1 = x, y
            x2, y2 = x + patch_size, y + patch_size

            if skip_non_full_patches and (x2 > width or y2 > height):
                continue  # skip incomplete patch

            x2 = min(x2, width)
            y2 = min(y2, height)

            patch = image[y1:y2, x1:x2]
            center = ((x1 + x2) // 2, (y1 + y2) // 2)

            patch_info = {
                "source_img": source_img_name,
                "patch_no": len(patches) + 1,
                "patch": patch,
                "center": center,
                "coordinates": {
                    "top_left": (x1, y1),
                    "top_right": (x2 - 1, y1),
                    "bottom_left": (x1, y2 - 1),
                    "bottom_right": (x2 - 1, y2 - 1)
                },
                "label": None,
                "overlap_flag": False
            }

            patches.append(patch_info)

    return patches

def read_images_csv(csv_path):
    # pre: file needs to be a valid path to a csv file
    # post: stripped list of first column values
    # desc: reads the csv file and returns a list of the first column values
    with open(csv_path, 'r') as file:
        lines = file.readlines()
    return [line.strip().split(',')[0] for line in lines]

def load_masks(image_name, mask_root, lesion_types: list) -> dict:
    # pre: image_name is a string representing the image file name,
    #      mask_root is a Path object pointing to the directory containing masks
```

```python
    #      and lesion_types is a list of strings representing lesion types.
    #
    # post: returns a dictionary of masks for each lesion type
    # desc: loads masks for the specified image from the given mask root␣
 ↪directory

    # todo: check is the extracted mask is all black if it is, yeet that bih...
    masks = {}

    for lesion in lesion_types:
        folder = MASKS_DIRS[lesion]
        mask_path = mask_root / folder / image_name

        if mask_path.exists():
            mask = cv2.imread(str(mask_path), 0)
            if mask is not None and np.count_nonzero(mask) != 0:
                masks[lesion] = (mask, False)  # not black
            else:
                masks[lesion] = (None, True)   # exists but all black
        else:
            masks[lesion] = (None, "unknown")  # doesn't exist

    return masks

def load_masks_for_all_images(mask_root, lesion_types: list):
    # pre: mask_root is a Path object pointing to the directory containing masks
    #      and lesion_types is a list of strings representing lesion types.
    #
    # post: returns a dictionary with image names as keys and their␣
 ↪corresponding masks as values
    # desc: loads masks for all images in the specified mask root directory
    image_paths = read_images_csv(CSV_FILE)
    cached_paths.extend(image_paths)  # cache the paths for later use

    masks = []

    for image in tqdm(image_paths, desc="Loading masks"):
        mask = load_masks(image, mask_root, list(MASKS_DIRS.keys()))
        masks.append(mask)

    return masks

def flatten_masks_to_df(masks, image_paths=cached_paths):
    # pre: image_paths is a list of image file names, masks is a list of␣
 ↪dictionaries
    # post: returns a pandas DataFrame with flattened mask information
    # desc: flattens the masks dictionary into a DataFrame for easier analysis
```

```
    records = []
    for image_name, mask_dict in zip(image_paths, masks):
        for lesion_type, (mask, flag) in mask_dict.items():
            records.append({
                "image_name": image_name,
                "lesion_type": lesion_type,
                "mask": mask,
                "mask_is_black": flag
            })
    return pd.DataFrame(records)

def plot_patch_with_lesions(df, n_cols=4, patch_size=25, resize_to=128):
    # pre: row is a pandas Series containing patch information,
    #      figsize is a tuple specifying the figure size,
    #      lesion_color is a string representing the color for the lesion patch,
    #      alpha is a float representing the transparency of the lesion patch
    # post: displays a plot of the patch with lesions highlighted
    # desc: plots a patch image with lesions highlighted using matplotlib

    n = len(df)
    n_rows = (n + n_cols - 1) // n_cols
    fig, axs = plt.subplots(n_rows, n_cols, figsize=(n_cols * 3.5, n_rows * 3.
↪5), dpi=150)
    axs = axs.flatten()

    for i, (_, row) in enumerate(df.iterrows()):
        patch_img = row['patch']
        patch_no = row['patch_no']
        label = row['label']
        lesion_shapes = row['lesion_shape']
        patch_poly = row['patch_polygon']
        ax = axs[i]

        patch_img_resized = cv2.resize(patch_img, (resize_to, resize_to),␣
↪interpolation=cv2.INTER_NEAREST)
        ax.imshow(patch_img_resized, cmap='gray' if patch_img.ndim == 2 else␣
↪None)

        label_text = ", ".join(label) if isinstance(label, (list, tuple)) else␣
↪label
        ax.set_title(f"#{patch_no} | {label_text}", fontsize=12)

        if isinstance(lesion_shapes, BaseGeometry):
            lesion_shapes = [lesion_shapes]
            label_list = [label] if isinstance(label, str) else label
        elif isinstance(lesion_shapes, list):
```

```
            label_list = label if isinstance(label, (list, tuple)) else [label]
        else:
            lesion_shapes, label_list = [], []

        x_offset, y_offset = row['coordinates']['top_left']

        for shape, lesion_type in zip(lesion_shapes, label_list):
            if not isinstance(shape, BaseGeometry):
                continue

            try:
                local_shape = translate(shape, xoff=-x_offset, yoff=-y_offset)

                scale_factor = resize_to / patch_size
                local_shape = scale(local_shape, xfact=scale_factor,␣
↪yfact=scale_factor, origin=(0, 0))

                color, alpha = COLOR_MAP.get(lesion_type, ('gray', 0.3))
                tick_color = TICK_COLOR_MAP.get(lesion_type, 'white')

                cx, cy = local_shape.centroid.xy
                ax.plot(cx[0], cy[0], marker='x', color=tick_color,␣
↪markersize=3.5, linewidth=0.6)
                ax.text(cx[0] + 2, cy[0] - 2, lesion_type, fontsize=10,␣
↪color=tick_color, weight='bold')

                poly_patch = mtpltlib_patches.Polygon(list(local_shape.exterior.
↪coords),
                                                      linewidth=3.0, edgecolor=color,
                                                      facecolor=color, alpha=alpha)
                ax.add_patch(poly_patch)
            except Exception as e:
                print(f"Skipped shape for {lesion_type}: {e}")

        ax.axis('off')

        for spine in ax.spines.values():
            spine.set_edgecolor("black")
            spine.set_visible(True)

    for j in range(i + 1, len(axs)):
        axs[j].axis('off')

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

1.3 Patch Labeling

[ ]:
```python
def build_final_patch_dataframe(patches_df, masks_df, resolve_by_area=False):
    # pre: patches_df is a DataFrame with patch information,
    #      masks_df is a DataFrame with mask information,
    #      resolve_by_area is a boolean flag to determine labeling strategy
    # post: returns a DataFrame with patches labeled and shapes determined
    # desc: processes patches and labels them based on intersection with lesion␣
↪shapes

    def patch_to_polygon(coord_dict): # mask not handled here
        # pre: coord_dict is a dictionary with keys 'top_left', 'top_right',␣
↪'bottom_right', 'bottom_left'
        # post: returns a shapely Polygon object representing the patch
        # desc: converts patch coordinates to a Polygon object
        return Polygon([
            coord_dict['top_left'],
            coord_dict['top_right'],
            coord_dict['bottom_right'],
            coord_dict['bottom_left']
        ])

    def generate_polygons_from_mask(mask: np.ndarray, epsilon=1.0, min_area=10):
        # pre: mask is a numpy array representing the binary mask,
        #      epsilon is a float for polygon simplification, min_area is a␣
↪float for minimum area
        # post: returns a list of dictionaries with polygon geometries
        # desc: generates polygons from a binary mask using contour detection

        contours = measure.find_contours(mask, 0.5)
        polygons = []
        for contour in contours:
            if len(contour) < 3:
                continue
            poly = Polygon(contour[:, ::-1])  # flip (row, col) to (x, y)
            if poly.area >= min_area:
                poly = poly.simplify(epsilon)
                if poly.is_valid:
                    polygons.append({'geometry': poly})
        return polygons

    def label_and_shape_patch(patch_poly, image_masks):
        # pre: patch_poly is a shapely Polygon object representing the patch,
        #      image_masks is a DataFrame containing mask information for the␣
↪image
        # post: returns a dictionary with label, lesion shape, and overlap flag
```

```python
    # desc: labels the patch based on intersection with lesion shapes in␣
↪the image masks

    # note: # to be removed later...here only for demo purposes
    labels = []
    shapes = []
    for _, row in image_masks.iterrows():
        lesion_type = row['lesion_type']
        lesion_shapes = row.get('shapes', [])
        for shape in lesion_shapes:
            poly = shape['geometry']
            if isinstance(poly, BaseGeometry) and patch_poly.
↪intersects(poly):
                labels.append(lesion_type)
                shapes.append(patch_poly.intersection(poly))
                break
    if labels:
        return {
            'label': tuple(labels) if len(labels) > 1 else labels[0],
            'lesion_shape': shapes[0] if len(shapes) == 1 else shapes,
            'overlap_flag': len(labels) > 1
        }
    else:
        return {
            'label': 'healthy',
            'lesion_shape': None,
            'overlap_flag': False
        }

# to be migrated to the pipeline
def label_patch_by_dominant_area(patch_poly, image_masks):
    # pre: patch_poly is a shapely Polygon object representing the patch,
    #      image_masks is a DataFrame containing mask information for the␣
↪image
    # post: returns a dictionary with label, lesion shape, and overlap flag
    # desc: labels the patch based on the dominant area of intersection␣
↪with lesion shapes in the image masks
    area_map = {}
    lesion_shapes_by_type = {}

    for _, row in image_masks.iterrows():
        lesion_type = row['lesion_type']
        for shape in row.get('shapes', []):
            poly = shape['geometry']
            if isinstance(poly, BaseGeometry) and poly.is_valid:
                intersection = patch_poly.intersection(poly)
                if intersection.is_empty:
```

```
                    continue
                intersect_area = intersection.area
                if intersect_area > 0:
                    area_map[lesion_type] = area_map.get(lesion_type, 0) +␣
↪intersect_area
                    lesion_shapes_by_type.setdefault(lesion_type, []).
↪append(intersection)

        if not area_map:
            return {
                'label': 'healthy',
                'lesion_shape': None,
                'overlap_flag': False
            }

        max_lesion = max(area_map.items(), key=lambda x: x[1])[0]

        return {
            'label': max_lesion,
            'lesion_shape': lesion_shapes_by_type[max_lesion],
            'overlap_flag': False
        }

    if 'shapes' not in masks_df.columns:
        masks_df = masks_df.copy()
        masks_df['shapes'] = masks_df.apply(
            lambda row: generate_polygons_from_mask(row['mask']) if␣
↪isinstance(row['mask'], np.ndarray) else [],
            axis=1
        )

    all_rows = []
    tqdm.pandas(desc="Processing patches")

    for image_name, group_df in tqdm(patches_df.groupby('source_img'),␣
↪desc="Processing images"):
        image_masks = masks_df[masks_df['image_name'] == image_name]
        group_df = group_df.copy()
        group_df['patch_polygon'] = group_df['coordinates'].
↪apply(patch_to_polygon)

        if resolve_by_area:
            label_results = group_df['patch_polygon'].progress_apply(
                lambda poly: label_patch_by_dominant_area(poly, image_masks)
            )
        else:
            label_results = group_df['patch_polygon'].progress_apply(
```

```
                lambda poly: label_and_shape_patch(poly, image_masks)
            )

        group_df['label'] = label_results.apply(lambda x: x['label'])
        group_df['lesion_shape'] = label_results.apply(lambda x:␣
↪x['lesion_shape'])
        group_df['overlap_flag'] = label_results.apply(lambda x:␣
↪x['overlap_flag'])

        all_rows.append(group_df)

    final_df = pd.concat(all_rows, ignore_index=True)
    return final_df
```

1.4 Process the Data

1.4.1 Patches

[ ]:
```
base_path = Path.cwd()
image_base_path = base_path.parent / 'data' / 'Seg-set' / 'Original_Images'

image_samples = ['0068_1.png', '0058_1.png', '0031_2.png']

patches_68 = []
patches_58 = []
patches_31 = []

patch_storage = {
    '0068_1.png': patches_68,
    '0058_1.png': patches_58,
    '0031_2.png': patches_31,
}

for image_name in image_samples:
    image_path = image_base_path / image_name

    rgb_image = load_original_image(image_path)
    # green_image = load_green_clahe_image(image_path) # will be used later,␣
↪using rgb now for visualization

    patches = extract_patches_with_metadata(
        rgb_image,
        patch_size=25,
        source_img_name=image_name
    )

    patch_storage[image_name].extend(patches)
```

1.4.2 Masks

```
[ ]: masks = load_masks_for_all_images(mask_root, list(MASKS_DIRS.keys()))
     masks_df = flatten_masks_to_df(masks)
```

```
Loading masks:   0%|          | 0/1842 [00:00<?, ?it/s]

Loading masks: 100%|     | 1842/1842 [01:11<00:00, 25.91it/s]
```

(Un)comment the first line to either re-run the whole process of loading the masks or to use the cached/already loaded masks (`cached_masks`).

[**DEPRECATED**] - was causing a lot of issues…since this was not cached "properly" but just assigned to a local var it was not saved in the notebook and thus not available for later runs.

> Note: runtime = `~ 1min 20 seconds`

```
[ ]: # ==== 0031_2.png ====
     patches_df_31 = pd.DataFrame(patches_31)
     patch_31_mask_df = masks_df[masks_df['image_name'] == '0031_2.png']
     final_patches_df_31 = build_final_patch_dataframe(patches_df_31,␣
      ↪patch_31_mask_df)
     # runtime: 7mins 20 seconds
     # ====================

     # ==== 0058_1.png ====
     patches_df_58 = pd.DataFrame(patches_58)
     patch_58_mask_df = masks_df[masks_df['image_name'] == '0058_1.png']
     final_patches_df_58 = build_final_patch_dataframe(patches_df_58,␣
      ↪patch_58_mask_df)
     # runtime: 22mins 13 seconds
     # ====================

     # ==== 0068_1.png ====
     patches_df_68 = pd.DataFrame(patches_68)
     patch_68_mask_df = masks_df[masks_df['image_name'] == '0068_1.png']
     final_patches_df_68 = build_final_patch_dataframe(patches_df_68,␣
      ↪patch_68_mask_df)
     # runtime: 7mins 20 seconds
     # ====================
```

```
Processing patches: 100%|      | 2704/2704 [00:00<00:00, 2757.80it/s]
Processing images: 100%|      | 1/1 [00:01<00:00,  1.01s/it]
Processing patches: 100%|      | 2704/2704 [00:00<00:00, 4057.46it/s]
Processing images: 100%|      | 1/1 [00:00<00:00,  1.44it/s]
Processing patches: 100%|      | 2704/2704 [00:00<00:00, 4548.67it/s]
Processing images: 100%|      | 1/1 [00:00<00:00,  1.61it/s]
```

Due to the "long" runtime(s), I saved the frame as a pickle (`.pkl`) file. This allows me to load it in a matter of seconds, rather than having to re-run the entire process. The process of saving the file is not included in this notebook, but could be deemed irrelevant…

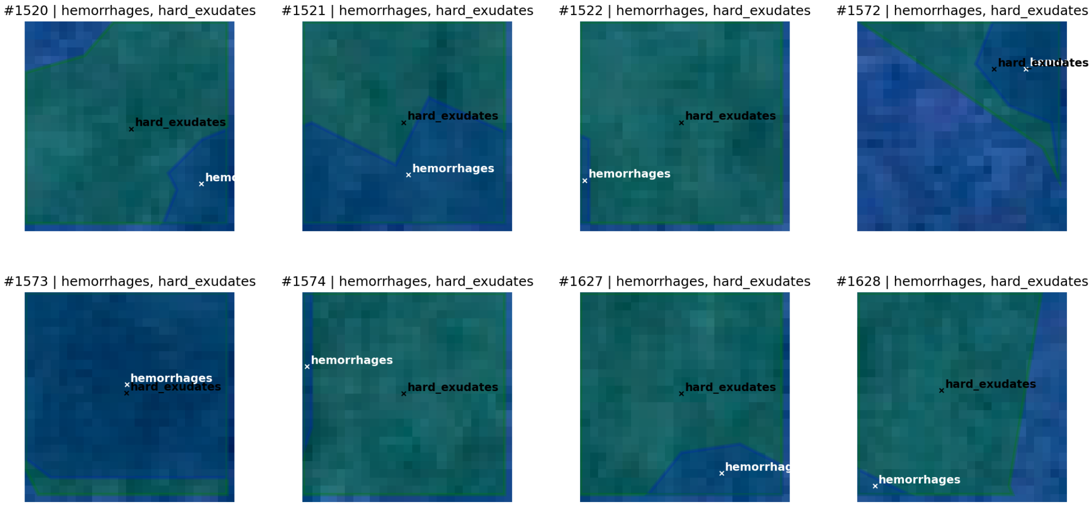
1.5 Testing (Visualizing) the Labeling Algorithm

0068_1.png

```
[ ]: overlapping_df_68 = final_patches_df_68[
         final_patches_df_68['label'].apply(lambda x: isinstance(x, tuple) and␣
       ↪len(x) > 1)
     ]

     display(overlapping_df_68["label"].unique())
     display(overlapping_df_68.head(n=2))
```

```
array([('hemorrhages', 'hard_exudates')], dtype=object)

      source_img  patch_no                                             patch  \
1519  0068_1.png      1520  [[[23, 80, 147], [15, 74, 144], [12, 67, 137],…
1520  0068_1.png      1521  [[[37, 89, 158], [35, 87, 155], [29, 82, 149],…

          center                                        coordinates  \
1519  (287, 737)  {'top_left': (275, 725), 'top_right': (299, 72…
1520  (312, 737)  {'top_left': (300, 725), 'top_right': (324, 72…

                           label  overlap_flag  \
1519  (hemorrhages, hard_exudates)          True
1520  (hemorrhages, hard_exudates)          True

                                        patch_polygon  \
1519  POLYGON ((275 725, 299 725, 299 749, 275 749, …
1520  POLYGON ((300 725, 324 725, 324 749, 300 749, …

                                         lesion_shape
1519  [POLYGON ((299 749, 299 737.8019607843137, 296…
1520  [POLYGON ((300 749, 324 749, 324 738.091994658…
```

```
[ ]: plot_patch_with_lesions(overlapping_df_68.head(8))
```



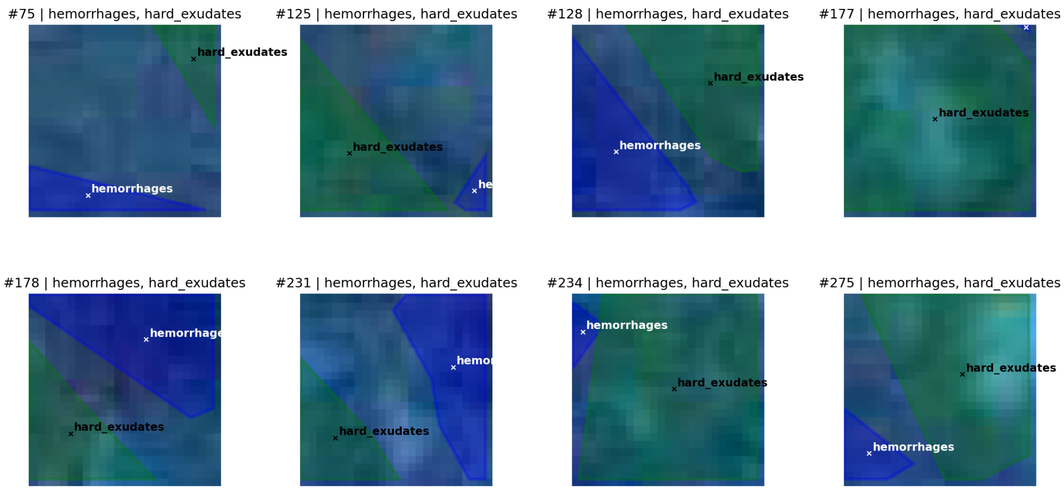
0058_1.png

```
[ ]: overlapping_df_58 = final_patches_df_58[
         final_patches_df_58['label'].apply(lambda x: isinstance(x, tuple) and␣
      ↪len(x) > 1)
     ]

     display(overlapping_df_58["label"].unique())
     display(overlapping_df_58.head(n=2))
```

```
array([('hemorrhages', 'hard_exudates'), ('hard_exudates', 'irma'),
       ('hemorrhages', 'irma'), ('microaneurysms', 'irma'),
       ('microaneurysms', 'hemorrhages', 'irma')], dtype=object)
```

```
     source_img  patch_no                                              patch  \
74   0058_1.png        75  [[[61, 96, 135], [62, 94, 134], [56, 90, 128],…
124  0058_1.png       125  [[[40, 75, 115], [38, 73, 112], [36, 71, 109],…

        center                                        coordinates  \
74   (562, 37)  {'top_left': (550, 25), 'top_right': (574, 25)…
124  (512, 62)  {'top_left': (500, 50), 'top_right': (524, 50)…

                             label  overlap_flag  \
74   (hemorrhages, hard_exudates)          True
124  (hemorrhages, hard_exudates)          True

                                         patch_polygon  \
74   POLYGON ((550 25, 574 25, 574 49, 550 49, 550 …
124  POLYGON ((500 50, 524 50, 524 74, 500 74, 500 …

                                          lesion_shape
74   [POLYGON ((550 49, 572.9921568627451 49, 550 4…
124  [POLYGON ((524 74, 524 66.90755421040393, 520…
```

```
[ ]: plot_patch_with_lesions(overlapping_df_58.head(8))
```

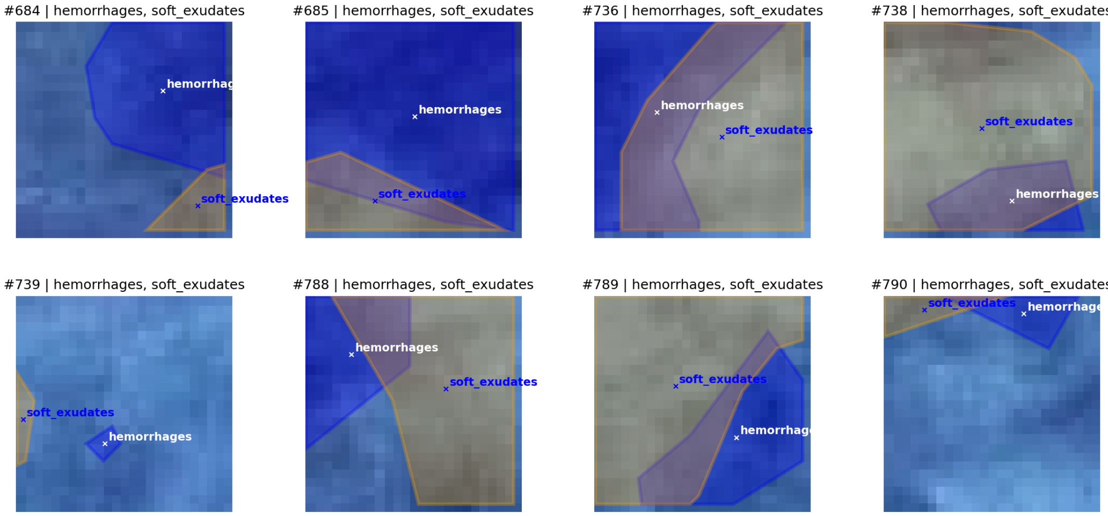


0031_2.png

[ ]:
```python
overlapping_df_31 = final_patches_df_31[
    final_patches_df_31['label'].apply(lambda x: isinstance(x, tuple) and␣
  ↪len(x) > 1)
]

display(overlapping_df_31["label"].unique())
display(overlapping_df_31.head(n=2))
```

```
array([('hemorrhages', 'soft_exudates'),
       ('microaneurysms', 'hemorrhages')], dtype=object)

     source_img  patch_no                                          patch  \
683  0031_2.png       684  [[[59, 94, 149], [61, 95, 150], [69, 103, 157]…
684  0031_2.png       685  [[[48, 73, 135], [44, 67, 131], [50, 74, 139],…

         center                                     coordinates  \
683  (187, 337)  {'top_left': (175, 325), 'top_right': (199, 32…
684  (212, 337)  {'top_left': (200, 325), 'top_right': (224, 32…

                          label  overlap_flag  \
683  (hemorrhages, soft_exudates)          True
684  (hemorrhages, soft_exudates)          True

                                      patch_polygon  \
683  POLYGON ((175 325, 199 325, 199 349, 175 349, …
684  POLYGON ((200 325, 224 325, 224 349, 200 349, …

                                        lesion_shape
683  [POLYGON ((199 325, 186.00196078431372 325, 18…
684  [POLYGON ((224 349, 224 325, 200 325, 200 343…
```

[ ]:
```python
plot_patch_with_lesions(overlapping_df_31.head(8))
```



1.6 Resolving Labels by Lesion Area Within the Patch

Same principle as before, only adjusted to fit the new dataset. The `build_final_patch_dataframe` function has been modified to resolve the labeling issue by area now. It can be toggled `ON/OFF` using the `resolve_by_area` flag. If set to `True`, the function will resolve the labels based on the area of the lesions within the patch. If set to `False`, it will simply create a tuple with all the lesion labels present in the patch

[ ]:
```python
final_resolved_patches_df_68 = build_final_patch_dataframe(patches_df_68,
    patch_68_mask_df, resolve_by_area=True)
```

```
Processing patches: 100%|      | 2704/2704 [00:01<00:00, 2229.78it/s]
Processing images: 100%|      | 1/1 [00:01<00:00,  1.24s/it]
```

[ ]:
```python
final_resolved_patches_df_58 = build_final_patch_dataframe(patches_df_58,
    patch_58_mask_df, resolve_by_area=True)
```

```
Processing patches: 100%|      | 2704/2704 [00:01<00:00, 1814.93it/s]
Processing images: 100%|      | 1/1 [00:01<00:00,  1.52s/it]
```

[ ]:
```python
final_resolved_patches_df_31 = build_final_patch_dataframe(patches_df_31,
    patch_31_mask_df, resolve_by_area=True)
```

```
Processing patches: 100%|      | 2704/2704 [00:02<00:00, 1071.08it/s]
Processing images: 100%|      | 1/1 [00:02<00:00,  2.55s/it]
```

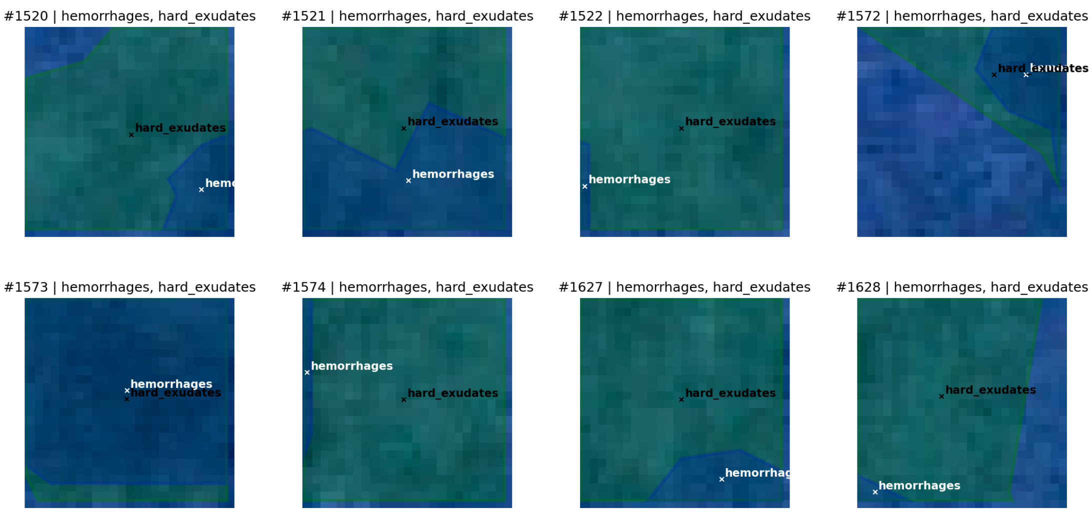
1.7 Results

0068_1.png

```
[ ]: same_patch_ids = overlapping_df_68[['source_img', 'patch_no']]
     matching_resolved_df_68 = final_resolved_patches_df_68.merge(
         same_patch_ids, on=['source_img', 'patch_no'], how='inner'
     )
```

Before

```
[ ]: plot_patch_with_lesions(overlapping_df_68.head(8))
```



After

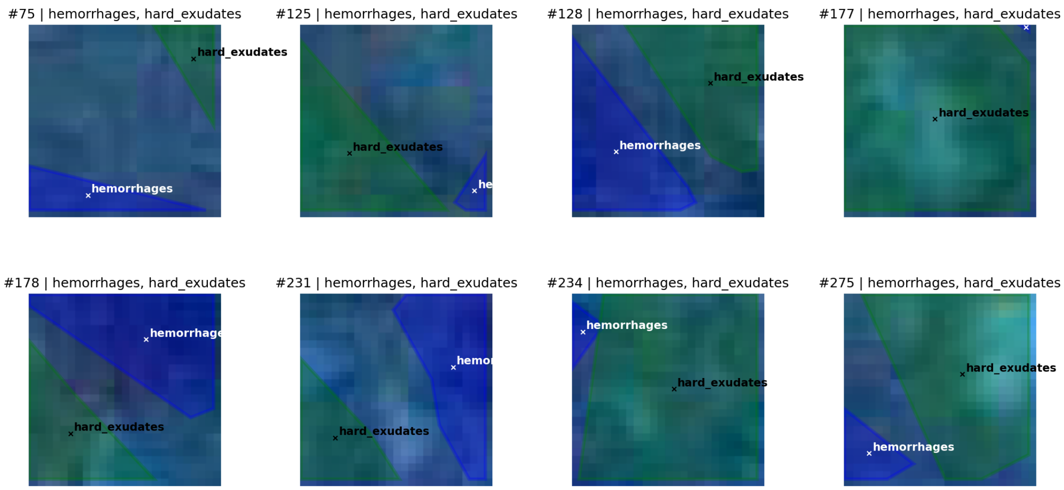
```
[ ]: plot_patch_with_lesions(matching_resolved_df_68.head(8))
```

0058_1.png

```
[ ]: same_patch_ids = overlapping_df_58[['source_img', 'patch_no']]
     matching_resolved_df_58 = final_resolved_patches_df_58.merge(
         same_patch_ids, on=['source_img', 'patch_no'], how='inner'
     )
```

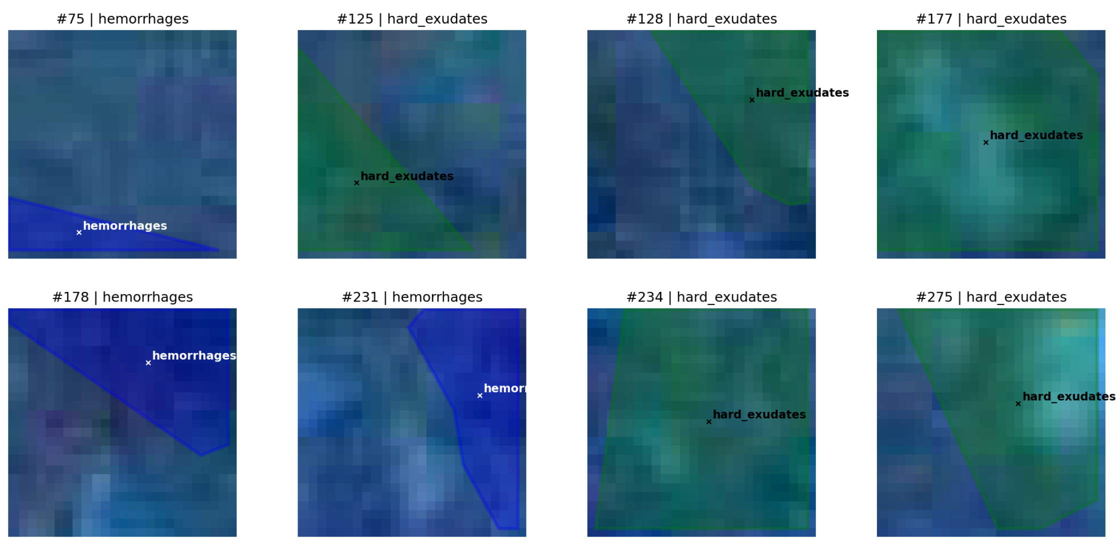
Before

```
[ ]: plot_patch_with_lesions(overlapping_df_58.head(8))
```



After

```
[ ]: plot_patch_with_lesions(matching_resolved_df_58.head(8))
```

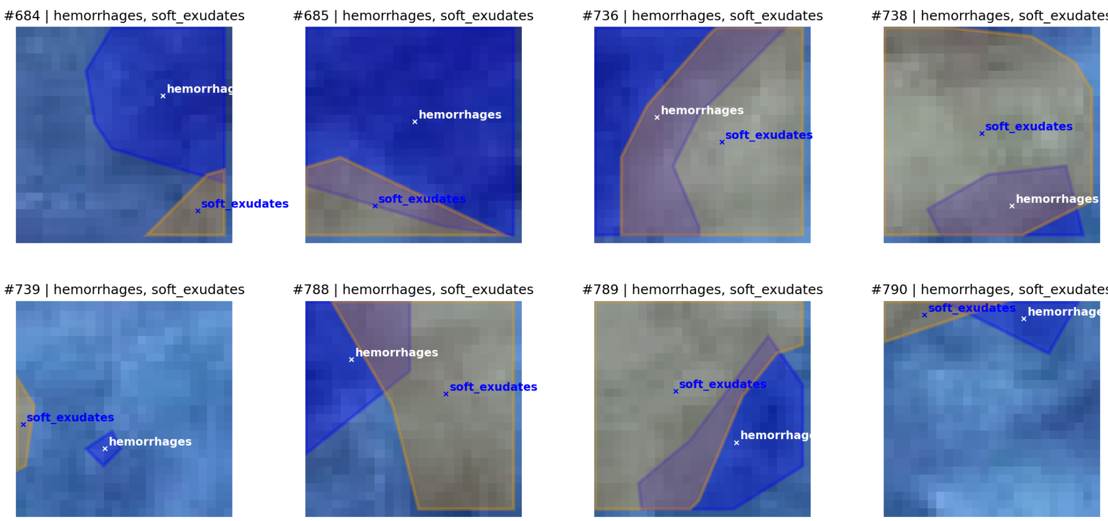


0031_2.png

```
[ ]: same_patch_ids = overlapping_df_31[['source_img', 'patch_no']]
     matching_resolved_df_31 = final_resolved_patches_df_31.merge(
         same_patch_ids, on=['source_img', 'patch_no'], how='inner'
     )
```

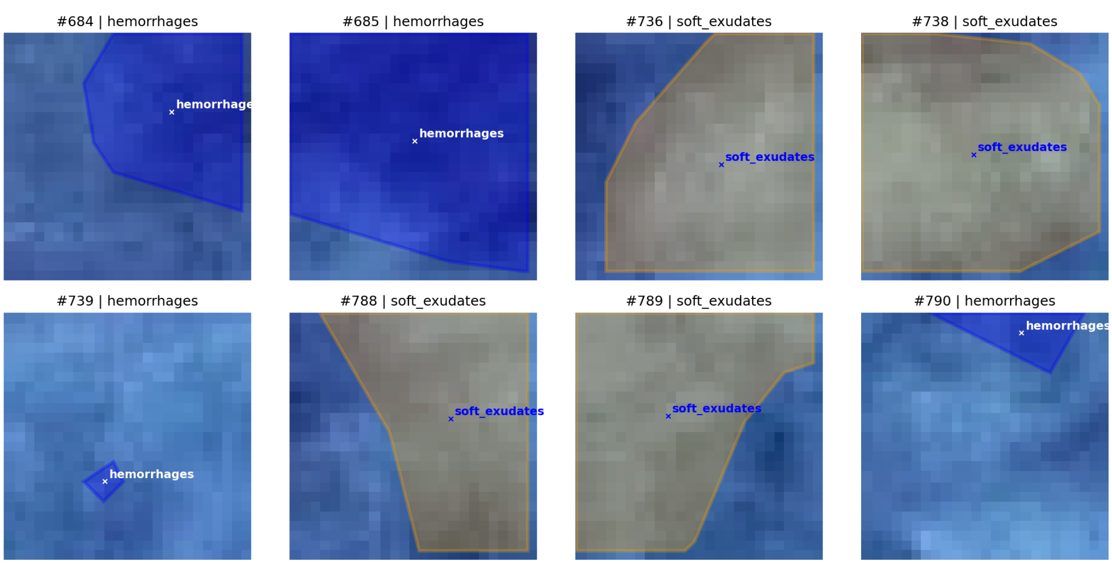
Before

```
[ ]: plot_patch_with_lesions(overlapping_df_31.head(8))
```



After

```
[ ]: plot_patch_with_lesions(matching_resolved_df_31.head(8))
```



If you're staring at this and thinking, "Why does one shape just suck the other one up?"…congrats, you're just as confused as I was. Turns out, after a bit of digging, the lesions actually do overlap in the original image (makes sense…).

But here's the kicker…when I use `matplotlib` to slap the patches on top of each other, they stack like a sandwich. So it looks like they've got neat little borders and aren't touching, BUT they are! It's just a visual trick caused by how the layers are rendered.