Clustering of polygons

Problem:

*Given a set of polygons, how do we efficiently recover one aggregate shape containing the region where **n** shapes overlapped?*

First, say the jupyter magic words 🧙

[1]
```
%matplotlib inline
%load_ext autoreload
%autoreload 2
```

Import the plethora of useful modules we'll need (including some we probably don't)

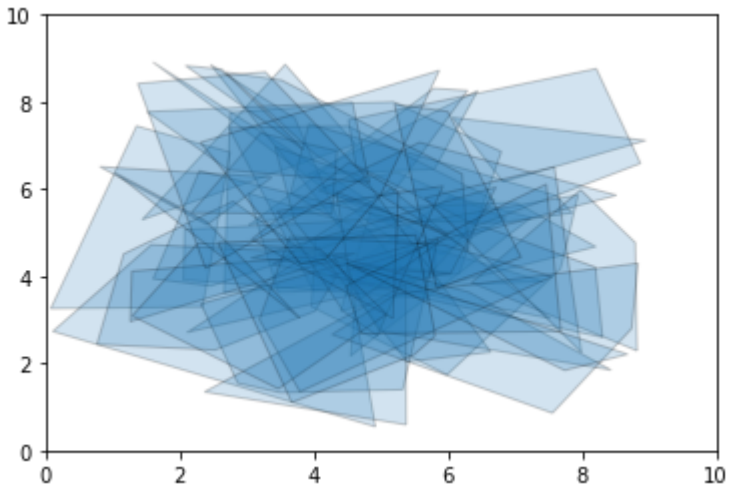
[2]
```
import numpy as np
import matplotlib.pyplot as plt
from descartes import PolygonPatch
from itertools import combinations
from shapely.geometry import Polygon, MultiPolygon
from shapely.affinity import translate
from shapely.ops import unary_union
```

Create some test shapes

[3]
```
shapes = []
for i in range(50):
    s = translate(
        Polygon([
            np.random.random(size=2)*5
            for i in range(np.random.randint(5) + 3)
        ]).convex_hull,
        xoff=np.random.randint(5),
        yoff=np.random.randint(5)
    )
    shapes.append(s)

shapes = MultiPolygon(shapes)
```

[4]
```
for poly in shapes:
    plt.gca().add_patch(PolygonPatch(poly, alpha=0.2))

plt.xlim(0, 10); plt.ylim(0, 10)
```

```
(0, 10)
```



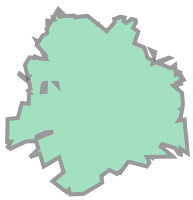
Make a 2d array of all intersections of objects

[5]
```
intersections_pass1 = [
    m.intersection(n)
    for i, m in enumerate(shapes)
    for n in shapes[i+1:]
]
grid_pass1 = np.zeros((len(shapes), len(shapes)), dtype=object)


upper_indices = np.triu_indices(len(shapes), k=1)
lower_indices = np.tril_indices(len(shapes), k=-1)

grid_pass1[upper_indices] = [
    m.intersection(n)
    for i, m in enumerate(shapes)
    for n in shapes[i+1:]
]
grid_pass1[lower_indices] = grid_pass1.T[lower_indices]
```

We'll also make a 2d array of intersection areas (coz we can)

[6]
```
areas_pass1 = np.zeros((len(shapes), len(shapes)), dtype=object)
areas_pass1[upper_indices] = [i.area for i in intersections_pass1]
areas_pass1[lower_indices] = areas_pass1.T[lower_indices]
```

[7]
```
out = Polygon()
for i, j, k, l in list(combinations(range(len(shapes)), 4)):
    zero_patch = any((
        grid_pass1[i, j].area == 0,
        grid_pass1[i, k].area == 0,
        grid_pass1[i, l].area == 0,
        grid_pass1[j, k].area == 0,
        grid_pass1[j, l].area == 0,
        grid_pass1[l, k].area == 0,
    ))
    if not zero_patch:
        four_poly = grid_pass1[i, j].intersection(grid_pass1[k, l])
        if four_poly.area != 0:
            out = out.union(four_poly)
out
```



[8]
```
for poly in shapes:
    plt.gca().add_patch(PolygonPatch(poly, alpha=0.2))
plt.gca().add_patch(PolygonPatch(out, alpha=0.8, fc='C1'))
plt.xlim(0, 10); plt.ylim(0, 10)
plt.axis('equal')
```

```
(-0.36901868518441994,
 9.39149009820649,
 0.12763515447204016,
 9.328523511954824)
```