Image-Evolution

November 29, 2017

1 Using a Genetic Algorithm to recreate an image

- **Goal**: Using a GA, we'll try to regenerate an image using a triangles overlain over each other.
- **Prequisites**: A small JPG (the extension and type is very important!) image (~ 100 x 100 to 200 x 200 pixels)
- **Reference**: Modified from: https://scturtle.me/posts/2014-04-18-ga.html

2 Imports

```
In [30]: from deap import base, creator, tools, algorithms
         from random import randint, random, gauss
         from PIL import Image, ImageDraw
         from functools import partial
         from math import sqrt
         from datetime import datetime
         import numpy
         import multiprocessing
         import matplotlib.pyplot as plt
```

Load the file and define some useful constants

```
In [39]: # Now load the image, and set some constants:
         filename = 'myimage.jpg'  # set your image name here
         IMG = Image.open(filename)
         WIDTH, HEIGHT = IMG.size
         NUMBER_OF_TRIANGLES = 50
         POPULATION = 40
         NGEN = 100
         POLY = 3
```

Now setup some convenience functions:

```
In [32]: def gen_one_triangle():
             return (tuple([(randint(0, WIDTH), randint(0, HEIGHT)) for i in xrange(POLY)]),
                     randint(0,255), randint(0,255), randint(0,255), randint(0,30))


         def triangles_to_image(triangles):
             im = Image.new('RGB', (WIDTH, HEIGHT), (255, 255, 255))
             for tri in triangles:
                 mask = Image.new('RGBA', (WIDTH, HEIGHT))
                 draw = ImageDraw.Draw(mask)
                 draw.polygon(tri[0], fill=tri[1:])
                 im.paste(mask, mask=mask)
                 del mask, draw
             return im
```

As before, we define our evaluation function:

```
In [33]: def evaluate(im1, t2):
             im2 = triangles_to_image(t2)
             pix1, pix2 = im1.load(), im2.load()
             ans = 0
             for i in xrange(HEIGHT):
                 for j in xrange(WIDTH):
                     a1, a2, a3 = pix1[i, j]
                     b1, b2, b3 = pix2[i, j]
                     ans += (a1 - b1) ** 2 + (a2 - b2) ** 2 + (a3 - b3) ** 2
             return 1 - (1. * sqrt(ans) / sqrt(WIDTH * HEIGHT * 3 * 255 * 255)),
```

Similarly, we configure our mutation function:

```
In [34]: def mutate(triangles):
             e0 = evaluate(IMG, triangles)
             for i in xrange(10):
                 tid = randint(0, NUMBER_OF_TRIANGLES - 1)
```

```
            oldt = triangles[tid]

            t = list(oldt)
            p = randint(0, 2 * POLY + 4 - 1)
            if p < 2 * POLY:
                points = list(t[0])
                pnt = list(points[p / 2])
                pnt[p % 2] = randint(0, WIDTH)
                points[p / 2] = tuple(pnt)
                t[0] = tuple(points)
            else:
                p -= 2 * POLY - 1
                t[p] = randint(0, 255)

            triangles[tid] = tuple(t)
            if evaluate(IMG, triangles) > e0:
                break
            else:
                triangles[tid] = oldt
        return triangles,  # note the trailing comma here!
```

Finally, we setup DEAP

```
In [35]: creator.create("Fitness", base.Fitness, weights=(1.0,))
         creator.create("Individual", list, fitness=creator.Fitness)

         toolbox = base.Toolbox()

         # multiprocessing
         pool = multiprocessing.Pool(processes=16)
         toolbox.register("map", pool.map)

         toolbox.register("attr", gen_one_triangle)
         toolbox.register("individual",
                          tools.initRepeat,
                          creator.Individual,
                          toolbox.attr,
                          NUMBER_OF_TRIANGLES)

         toolbox.register("population",
                          tools.initRepeat,
                          list,
                          toolbox.individual)

         toolbox.register("evaluate", partial(evaluate, IMG))
         toolbox.register("mate", tools.cxTwoPoint)
         toolbox.register("mutate", mutate)
         toolbox.register("select", tools.selTournament, tournsize=3)
```

Now we attempt evolve the image. Note that this can take a long time (~ hours) if a large image is used!

```
In [42]: start = datetime.now()
         verbose = False
         pop = toolbox.population(n=POPULATION)
         hof = tools.HallOfFame(1)

         stats = tools.Statistics(lambda ind: ind.fitness.values)
         stats.register("min", numpy.min)
         stats.register("max", numpy.max)
         stats.register("avg", numpy.mean)
         stats.register("std", numpy.std)

         try:
             pop, log = algorithms.eaSimple(pop,
                                            toolbox,
                                            cxpb=0.5,
                                            mutpb=0.1,
                                            ngen=NGEN,
                                            stats=stats,
                                            halloffame=hof,
                                            verbose=verbose)
         finally:
             if len(hof) > 0:
                 # Save the results
                 open('result.txt', 'w').write(repr(hof[0]))
                 triangles_to_image(hof[0]).save('result.png')

         print datetime.now() - start  # tell us how much time has elapsed
```

```
0:00:37.032754
```

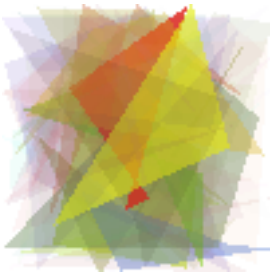
Compare the results:

```
In [37]: import IPython.display as display
         display.Image(filename='myimage.jpg') # original
```

Out[37]:

```
In [38]: display.Image(filename='result.png')
```

Out[38]:



3 Activity 1: What happens when we use a different polygon?

4 Activity 2: What happens when we vary the population and the number of polygons?

```
In [ ]:
```