Lab 06-Textons and classifiers

Juan Carlos Leon Alcazar

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1 Description of the database

The database[1] contains 1000 gray scale images in JPG format, every images has a 640*480 pixels resolution. Images are close ups of a given object surface, thus, containing textures found in different objects [1]. There are 40 samples for each class. The databaset is divided into test and train. There is a final idex file plain text file with the naming convention for the images.

2 ...

Time considwerations.

The tetxon calculation is a time consuming task, the following table sumarizes the timae taken according to the amount of images utilized to build the database

images	resolution	time (S)
1		
2		38
3		250
4		389

Differentiation is now a technique taught to mathematics students throughout the world. In this document I will discuss some aspects of differentiation.

3 Exploring the derivative using Sage

The definition of the limit of $f(x)$ at $x = a$ denoted as $f'(a)$ is:

$$f'(a) = \lim_{h \to 0} \frac{f(a+h) - f(a)}{h} \tag{1}$$

The following code can be used in sage to give the above limit:

[1]The object clases are: Bark Wood, Water, Granite, Marble, Floors, Pebbles, Wall Brick, Glass, Carpet, Upholstery, Wallpaper, Fur, Knit, Corduroy & Plaid

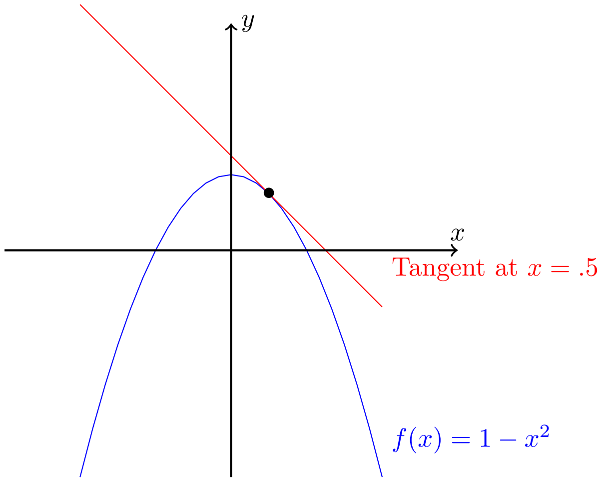

Figure 1: The plot of $f(x) = 1 - x^2$ with a tangent at $x = .5$.

```
def illustrate(f, a):
    """
    Function to take a function and illustrate the limiting definition of a derivative at
    """
    lst = []
    for h in srange(.01, 3, .01):
     lst.append([h,(f(a+h)-f(a))/h])
    return list_plot(lst, axes_labels=['$x$','$\\frac{f(%.02f+h)-f(%.02f)}{h}$' % (a,a)])
```

If we want to plot the tangent at a point α to a function we can use the following:

$$
\begin{aligned}
y =& ax + b && \text{(definition of a straight line)}\\
& f'(a)x + b && \text{(definition of the derivative)}\\
& f'(a)x + f(a) - f'(a)a && \text{(we know that the line intersects } f \text{ at } (a, f(a)))
\end{aligned}
$$

We can combine this with the approach of the previous piece of code to see how the tangential line converges as the limiting definition of the derivative converges:

```
def convergetangentialline(f, a, x1, x2, nbrofplots=50, epsilon=.1):
    """
    Function to make a tangential line converge
    """
    clrs = rainbow(nbrofplots)
    k = 0
    h = epsilon
    p = plot(f, x, x1, x2)
    while k < nbrofplots:
        tangent(x) = fdash(f, a, h) * x + f(a) - fdash(f, a, h) * a
        p += plot(tangent(x), x, x1, x2, color=clrs[k])
```

```
        h += epsilon
        k += 1
    return p
```

The plot shown in Figure **??** shows how the lines shown converge to the actual tangent to $1 - x^2$ as $x = 2$ (the red line is the 'closest' curve).

Note here that the last plot is given using the **real** definition of the derivative and not the approximation.

4 Conclusions

In this report I have explored the limiting definition of the limit showing how as $h \to 0$ we can visualise the derivative of a function. The code involved `https://sage.maths.cf.ac.uk/home/pub/18/` uses the differentiation capabilities of Sage but also the plotting abilities.

There are various other aspects that could be explored such as symbolic differentiation rules. For example:

$$\frac{dx^n}{dx} = (n+1)x^n \text{ if } x \neq -1$$

Furthermore it is interesting to not that there exists some functions that **are not** differentiable at a point such as the function $f(x) = \sin(1/x)$ which is not differentiable at $x = 0$. A plot of this function is shown in Figure **??**.

References

[1] S. Lazebnik, C. Schmid, and J. Ponce. A sparse texture representation using local affine regions. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 27(8):1265–1278, Aug 2005.