Lab 06-Textons and classifiers

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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 Methodlogy

The first step in the classifiaction is the construction of a texton dictionary from the subset 'train'. Due to memory constrains, it was not possible to build this dictionary with the complete train set (750 images). Creating a texton dictionary with a set of 40 images requires about 42 GB of RAM memory (At peak), while requiring about 3 hors procesing time. For the experiments that follow a single 115GB RAM machine was avaialabe. Thus the trainign set was reduced to 85 images.

This reduction in the trainig set creates a side probem as it is not clear how to sample the iamges withpunt creating a significant bias. However texture is local information, it can be assume that each image constins several istances of the local patters

btreve experimento con las direebcias del hstograma a medidia que se aumenta el numeor de imagenes

2.1 Textons

AFter selecting the initial number of training images, there reamins one parameter for the consturcition of the texton dictionary. We use a number of tetxtons given by $N = k32$ ($K = 1, 2, 3$). The explanation behind this choice is that we expected the local pattern to closelmatch the shpahe of the textons, this is the case of , k=1 $\rightarrow$ N=32 (remember the initial filtyer bank has a size of 32). How ever not in every clase the local pattern will match exactly one of the textons on the filterbank. This is the case where $K = 2, 3$ the resulting clisters contain the resposne infomation cretae by ombining filter responses.

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[1]The object clases are: Bark Wood, Water, Granite, Marble, Floors, Pebbles, Wall Brick, Glass, Carpet, Upholstery, Wallpaper, Fur, Knit, Corduroy & Plaid
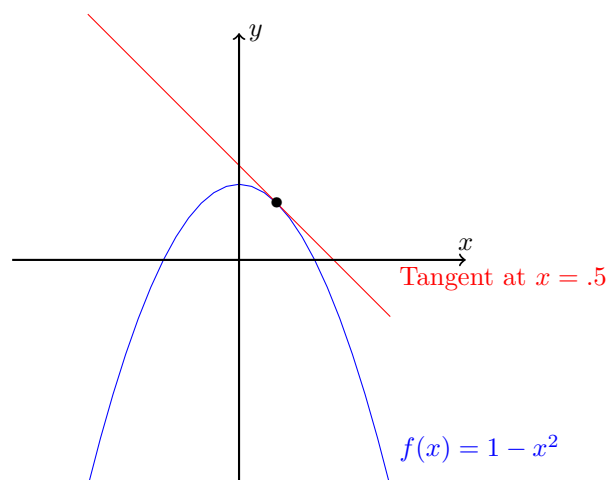
Figure 1: The plot of $f(x) = 1 - x^2$ with a tangent at $x = .5$.

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:

```
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.