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.

We have not a clear way to subsample the original training set so thta variability is not significvcanly changed, in other words, this reduction in the trainig set could create a large bias.

However the natre of the dataset might help to mitigate this issue: textures are essentially local patterns repeated, with some variability, at the global level. Thus it can be assumed that each image constins several instances of these local patters that already containsome of the variability of the texture.

To further test this hypotesis...

btreve experimento con 4 histogramas T1,5Imagenes T1n30I mages, T2n5Imagens,T2n30Images distancia chi-cuadrado

2.1 Textons

After selecting the initial number of training images, there remains one final parameter for the construction of the texton dictionary. We use a number of textons given by $N = k32$ $(K = 1, 2, 3)$. The explanation behind this choice

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

is that we expected the local patterns to closely match the shape of the filter bank; This is the case of k=1 $\rightarrow$ N=32 How ever, not every the local pattern will match perfectly one of the textons on the filterbank. This is the case of $K = 2, 3$ where the resulting clusters might contain resposne infomation cretaed by combining filter responses. No further values for K are explored mostly, due to time constrains.

The final setup for the texton dictionary construction is the following:

- Filter Bank: default filterbank provide in the implementatios 16 orientaions, 2 scales
- Number of training images: 85 (5 per each class)
- Number of clusters (N): 32,64,96

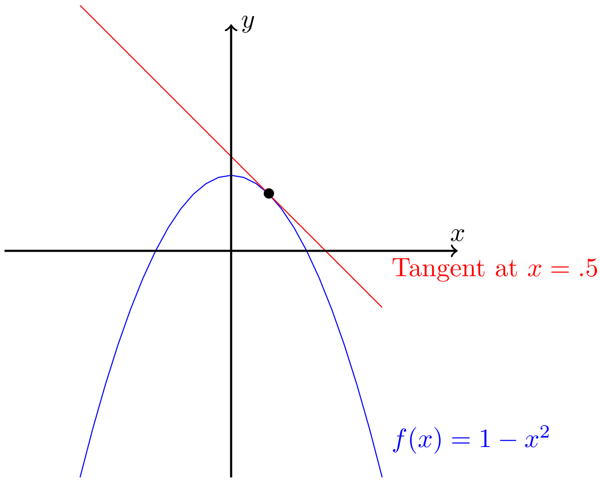

Figure 1: The plot of $f(x) = 1 - x^2$ with a tangent at $x = .5$.

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.