$ Exploding Gradient in $\sigma(x)$ & $\tanh(x)$

Generally, $\sigma(x)$ & $\tanh(x)$ are known to face vanishing gradient.
But in an extremely rare case scenario, they can also face exploding gradient.
In exploding gradient, gradient value becomes very large and this leads to too much variation in the weights.

Eg. Sigmoid Activation function, Input layer W_1

$$\frac{\partial L}{\partial w_1} = \underbrace{\frac{\partial L}{\partial O_4} \cdot \frac{\partial O_4}{\partial O_3} \cdot \frac{\partial O_2}{\partial O_1} \cdot \frac{\partial O_1}{\partial w_1}}$$

The terms here become bigger than 1 for very large weights and as a result the final value can be greater than 1.

$ What is an Image?

An image is a rectangular array of dots called pixels. The size of an image is specified in terms of width $\times$ height in terms of pixels.

→ The physical size of the image, depends upon the resolution of device on which the image is displayed. The resolution is measured in DPI (Dots Per Inch).

↳ An Image will appear smaller on a device with higher resolution and vice versa, provided the same image is being talked about.

↳ For color images : we need enough bits/pixel to represent all colors in the image. The number of bits/pixel is called the depth of the image

Image Datatypes

↳ monochrome image is created using a single color.

↳ Color images can be created by using multiple colors.

① 1-bit Image:

In this each pixel is stored as 0 or 1

0	1
on	off
white	Black
true	false

aka: Binary Image, 1-bit monochrome image,

eg: 1-bit image with a resolution 640 × 480

Calculate the storage space

640×480 bits $\Rightarrow \dfrac{640 \times 480}{8}$ (bytes) $\Rightarrow \dfrac{640 \times 480}{8 \times 1024}$ (KB) $= 37.5$ KB

without compression

* The clarity / Quality of 1-bit Image is very low

② 8-bit Gray level Images:

↳ Each pixel in this case is represented by a single byte (8 bits).

⇒ Each pixel can hold $2^8 = 256$ values i.e. 0 to 255.

0 ——	255
Black	White
No Intensity / Brightness	Full Intensity / Brightness

* Images are exclusively composed of gray shades

↳ A grayscale digital image is an image in which the value of each pixel is a single sample, which carries intensity informat^n.

eg. dark pixel may have value = 15

whereas a bright one = 240

* grayscale image aka monochromatic image *

* An image is represented by a bit map. A bit map is a simple matrix of tiny pixels that form an image which is either displayed on a computer screen or printed.

Q- Calculate storage space of an 8 bit image with resolution 640×480

Ans-

$$640 \times 480 \text{ bytes} \Rightarrow \left(\frac{640 \times 480}{1024}\right) KB = 300 KB$$

{Almost 8 to 10 times the storage of 1-bit image}

without compression

(3) 24-bit Color Images:

↳ In this format of Image, each pixel is represented by 3 bytes. These 3 bytes usually represent RGB.

↳ A true color is defined to mean 256 shades of RGB for a total of 16.7 million color variations.

↳ These images provide a method of representing & storing a graphical image information in an RGB colorspace. This allows for colors, shades & hues in large no. of variations to be displayed in an image. As a result, we get high quality photos / complex graphics

↳ The 24-bit Images are often stored as 32 bit images and an extra byte for each pixel is used to store an alpha value representing special effect information

Q- Storage space for a 24 bit Image of 640×480 size

Ans-

$$\Rightarrow 640 \times 480 \times 3$$

$$\Rightarrow \left(\frac{640 \times 480 \times 3}{1024}\right) KB$$

$$\Rightarrow 900 KB \text{ (without compression)}$$

Now, when the extra byte is added:

$$640 \times 480 \times 4 = 1200 KB \text{ (without compression)}$$

Problems: (1) Requires a lot of storage space

(2) Most monitors are only able to display 256 colors at a time. So the rest becomes wasteful.

(4) 8-bit Color Images:

↳ Each pixel is represented by 1 byte (8 bits).

⇒ the max. no. of colors which can be displayed is 256 (0 - 255)

8-bit color graphics are of 2 forms

→ In this the color is not stored instead, an 8-bit index is stored into the color map of each pixel, instead of storing the full 24 bit color value.

→ 8-bit image format has 2 parts

(i) a color map describing what colors are present in the image

(ii) an array of index values for each pixel in image.

*. In most color maps, each color is usually chosen from a pallette of 16.7 million colors.

24 bits: 8 Red
8 Green
8 Blue

→ In this form the bifocation of 8 bits is as follows
3 - Red, 3 - Green, 2 - Blue.

→ It is often called 8-bit true color as it doesn't use the pallette wall.

→ When a 24 bit full color image is turned into 8-bit Image, some colors have to be eliminated which is called color quantization process.

Q. 8-bit color Image of 640 × 480 ⇒ storage space

$$\Rightarrow 640 \times 480 \text{ bytes} \Rightarrow \left(\frac{640 \times 480}{1024}\right) \text{KB} = 300 \text{KB}$$

without compression.

Color Spaces

* A color space refers to a specific organization of colors. It specifies mapping between numeric values and specific colors which are called 'primaries' in that color space.

Adobe & IMAX have their own proprietary color spaces as well.

* The three most used color spaces are:
  1. RGB (Red, Green, Blue) → used for website images, as displays best on monitor.
  2. CMYK (Cyan, Magenta, Yellow, Key): used for print due to large color variations.
  3. HSV (Hue, Saturation, Value): considered best for editing purpose because it separates out lightness variations from the hue & saturatⁿ variations.

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* A color space is the range of colors that an image editing prog. can display.
  eg. RGB16, CMYK100 etc.
  └ 16 bit RGB almost 280 Trillion colors

  ↳ The color space numbers are important when you are preparing images to be printed professionally or sent to a photo lab.

* Images with different color spaces can't be mixed together equally or be printed on same paper.

* Additive V/S Subtractive Color Space

Additive (RGB)	Subtractive (CMYK)
They are obtained by light emitted	They are opposite
R+G+B = White	C+M+Y = Black [Not so convincing, so K is also used]

References:

https://filmlifestyle.com/what-is-color-space/
https://uxplanet.org/basic-guide-to-understanding-colors-2301c9d777f8
https://pixelsandwanderlust.com/the-difference-between-clarity-sharpness-and-contrast-sliders/

Image File Formats

1.) GIF (Graphical Interchange format):

- Created by compuserve
- Supports 256 colors (creates a table of 256 color from a pool of 16 million)
- Renders images without any quality loss.
- In case there are multiple colors, it uses algo. to match the colors of the image with the palette of optimum set of 256 colors.
- It lossless for image with less than 256 colors.
- In case of rich, true color image it looses 99% colors.

2.) JPEG (Joint Photographic Experts Group):

- bitmapped Image
- stores information as 24-bit color.
- used widely in almost all fields
- It uses lossy compression, in order to make the file small.
- not good for animation, transparency, lettering, simple cartoon etc.

3.) PNG (Portable Network Graphics):

- Only lossless format that webbrowsers support.
- Supports 8-bit, 24-bit, 32-bit & 48-bit data types.

★ 3.) TIFF (Tagged Image File Format):

now used & controlled by Adobe

- developed by Aldus Corp in 1980 and later supported by microsoft.
- used by many editing & retouch applications.
- Can store 1-bit grayscale to higher bit RGBs.
- Originally used lossless compression but now it can also do lossy compression if needed.

4.) BMP (Bit Map)
5.) EPS (Encapsulated Post Script)
6.) PDF (Portable Document format)
7.) EXIF (Exchange Image file)
8.) WMF (Windows Meta File)
9.) PICT (used in MAC, prone to corruption)
10.) Photoshop (Adobe proprietary)
11.) HEIC (High Efficiency Image Container)

Contrast V/S Clarity V/S Sharpness

Contrast → overall tonal range of photo is adjusted
↳ making lights lighter & darks darker

Clarity → Adjust the mid tones of the photo

Sharpness → deals at pixel level
↳ makes the contrast b/w each pixel more or less pronounced.

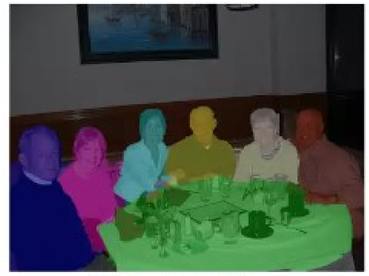
Image Recognition
↳ Image Recognition or Image Classification is the task of identifying images and categorizing them into one of several predefined distinct classes.

The field of study aimed at enabling machines with this ability is called computer vision

Image Classification with localization
↳ placing an image in a given class and drawing a bounding box around an object to show where its located in an image

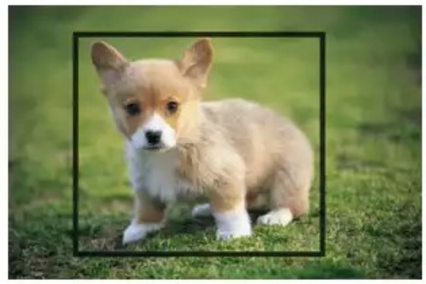
Object Detection

Semantic Segmentation



Instance Segmentation

Object Classification is the task of identifying that picture is a dog



Object Localization involves the class label as well as a bounding box to show where the object is located.

Object Detection

↳ Categorizing multiple different objects in the image and showing the location of each of them with bounding boxes.

↳ It is a variation of the image classification with localization tasks for numerous objects.

object (semantic) Segmentation

↳ Identifying specific pixels belonging to each object in an image instead of drawing bounding boxes around each object as in object detection.

Instance Segmentation

↳ differentiating multiple objects (instances) belonging to the same class (each person in a group)