Image Data Augmentation (Week 8)

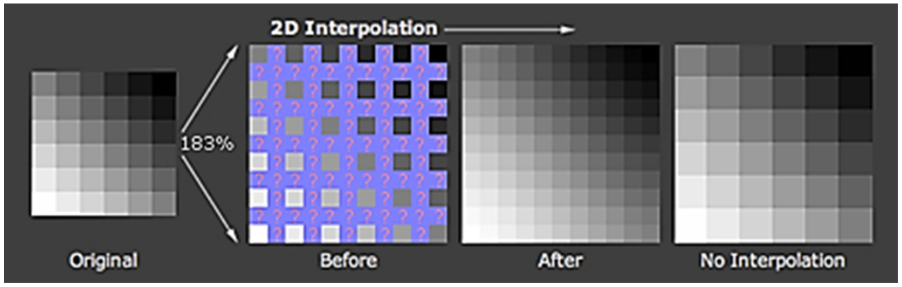
Image Data Augmentation

- Data augmentation
  - It is a set of techniques that enhance the size and quality of machine learning training datasets so that better learning models can be trained with them.
- Image augmentation
  - It is the procedure of improving the quality and information content of original data before processing. Examples include:
  - Filtering with morphological operators
  - Noise removal using filters
  - Gamma transformations
  - Contrast adjustment
  - Histogram equalisation, etc.

Interpolation

Interpolation

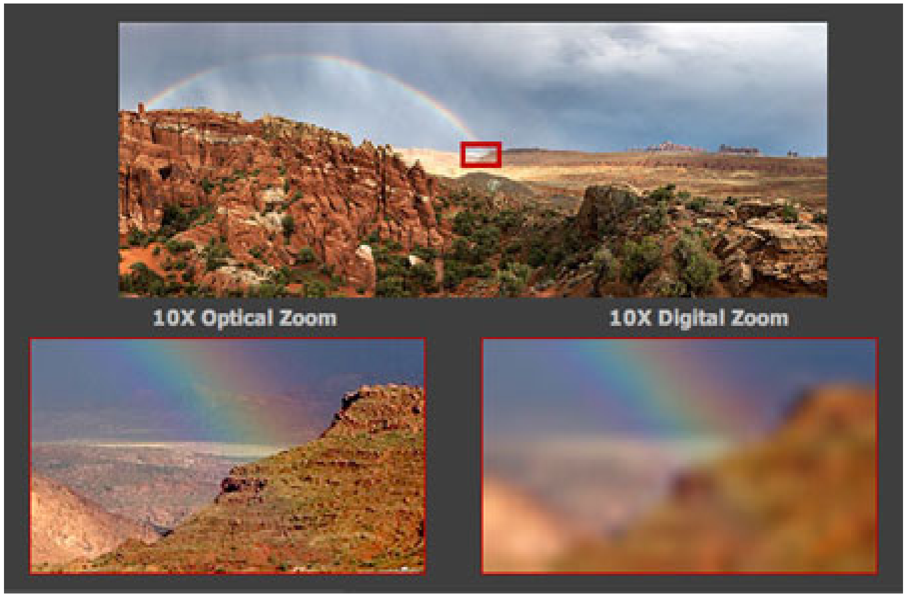
- What happens when the template size slightly mismatches with the frame information?
- Interpolation is a method of creating new data points within the range of known data points.



- Resizing an image (or a feature map) to a desired spatial dimension is a common operation when building AI applications.
- Helpful in case of template matching, when the size of the template mismatches with the frame information.
- Can create possible templates of different sizes to match the frame information.

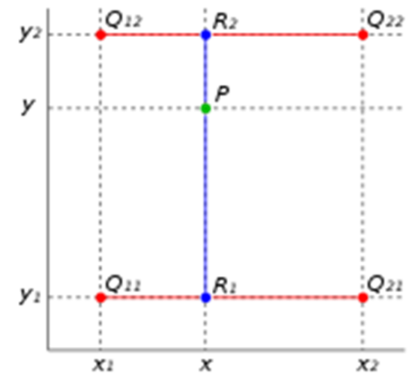
Interpolation: Digital zoom

- Many compact digital cameras can perform both an optical and a digital zoom.
- A camera performs an optical zoom by moving the zoom lens so that it increases the magnification of light before it even reaches the digital sensor.
- In contrast, a digital zoom degrades quality by simply interpolating the image — after it has been acquired at the sensor.



Bilinear Interpolation

- Bilinear interpolation is a method for interpolating functions of two variables (e.g., x and y) using repeated linear interpolation.
- We first do linear interpolation in the x-direction:



$$R_1 = f(x, y_1) = \frac{x_2 - x}{x_2 - x_1} f(Q_{11}) + \frac{x - x_1}{x_2 - x_1} f(Q_{21}),$$

$$R_2 = f(x, y_2) = \frac{x_2 - x}{x_2 - x_1} f(Q_{12}) + \frac{x - x_1}{x_2 - x_1} f(Q_{22}).$$

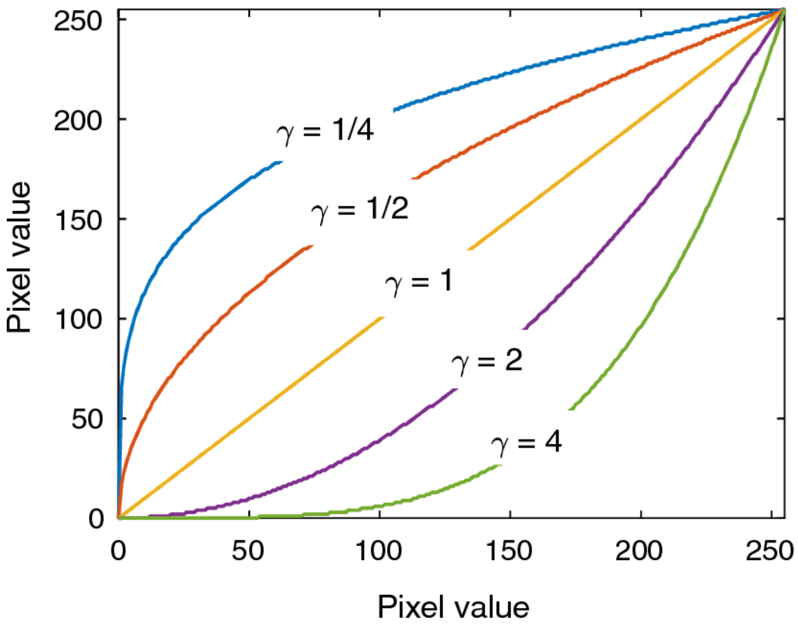
- Interpolating in the y-direction:

$$\begin{aligned} P = f(x, y) &= \frac{y_2 - y}{y_2 - y_1} f(x, y_1) + \frac{y - y_1}{y_2 - y_1} f(x, y_2) \\ &= \frac{y_2 - y}{y_2 - y_1} \left(\frac{x_2 - x}{x_2 - x_1} f(Q_{11}) + \frac{x - x_1}{x_2 - x_1} f(Q_{21}) \right) + \frac{y - y_1}{y_2 - y_1} \left(\frac{x_2 - x}{x_2 - x_1} f(Q_{12}) + \frac{x - x_1}{x_2 - x_1} f(Q_{22}) \right) \end{aligned}$$

Image Data Adjustment

Gamma Adjustments

- Gamma correction is a nonlinear operation for encoding and decoding luminance in video or digital images.
- When a camera records video or a digital image, it's more sensitive to the light coming in than humans are.
  - If twice as many photons hit the camera sensor as usual, the camera registers twice as many photons. It has a linear relationship to the brightness coming in.
  - However, humans do not. When we see, if our eyes received twice as many photons, we'd perceive a much smaller increase in brightness.



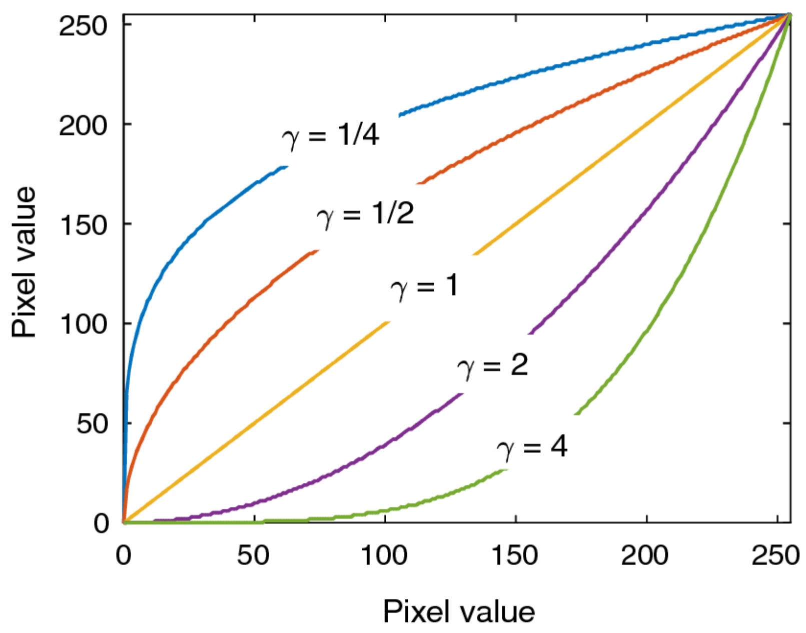
Gamma Adjustments

- The general form of gamma transformation function is:

$$s = c \times r^{1/\gamma}$$

where, 's' and 'r' are the output and input pixel values, respectively and 'c' and 'γ' are the positive constants.

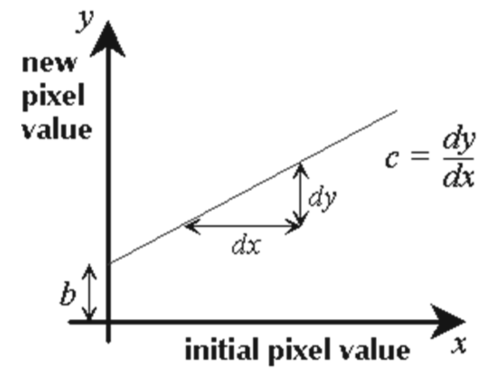
- Gamma law curves with $\gamma < 1$ map a narrow range of dark input values into a wider range of output values.
- Similarly, for $\gamma > 1$, map a wide range of dark input values into a narrow range of output values.



Linear Contrast Adjustment

- There are a number of models which can be used to adjust image contrast.
- The most popular is the linear contrast stretch.
- In this model, if an image pixel has initial value x. Its new updated value can be estimated using:

$$y = cx + b$$



Linear Contrast Adjustment: RGB Image Data