NUS-ISS
Vision Systems

Module 3 - Foundations of computer vision system (2) - Local feature and representation, part 1

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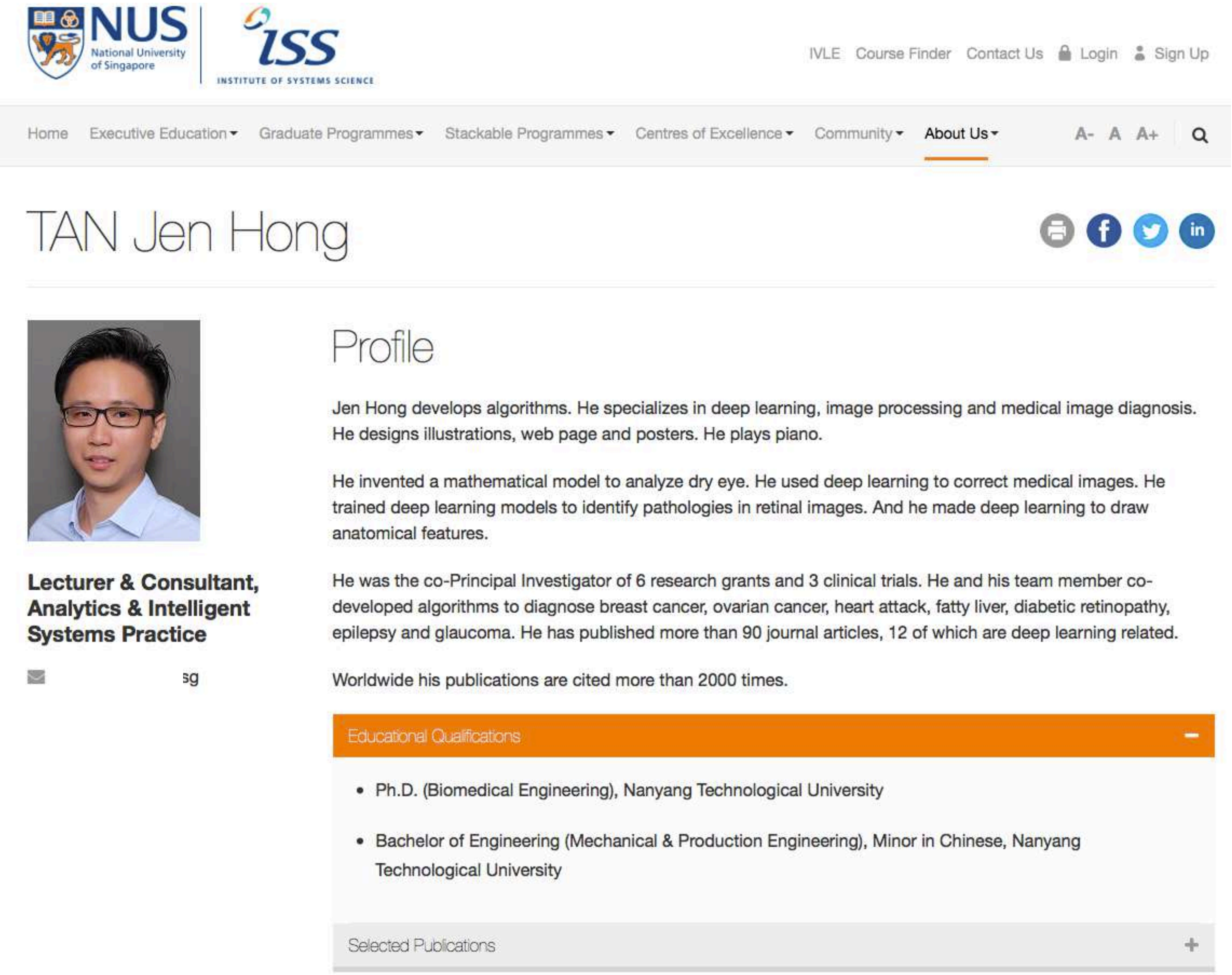

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Profile

Jen Hong develops algorithms. He specializes in deep learning, image processing and medical image diagnosis. He designs illustrations, web page and posters. He plays piano.

He invented a mathematical model to analyze dry eye. He used deep learning to correct medical images. He trained deep learning models to identify pathologies in retinal images. And he made deep learning to draw anatomical features.

He was the co-Principal Investigator of 6 research grants and 3 clinical trials. He and his team member co-developed algorithms to diagnose breast cancer, ovarian cancer, heart attack, fatty liver, diabetic retinopathy, epilepsy and glaucoma. He has published more than 90 journal articles, 12 of which are deep learning related.

Worldwide his publications are cited more than 2000 times.

Educational Qualifications

- Ph.D. (Biomedical Engineering), Nanyang Technological University
- Bachelor of Engineering (Mechanical & Production Engineering), Minor in Chinese, Nanyang Technological University

Selected Publications

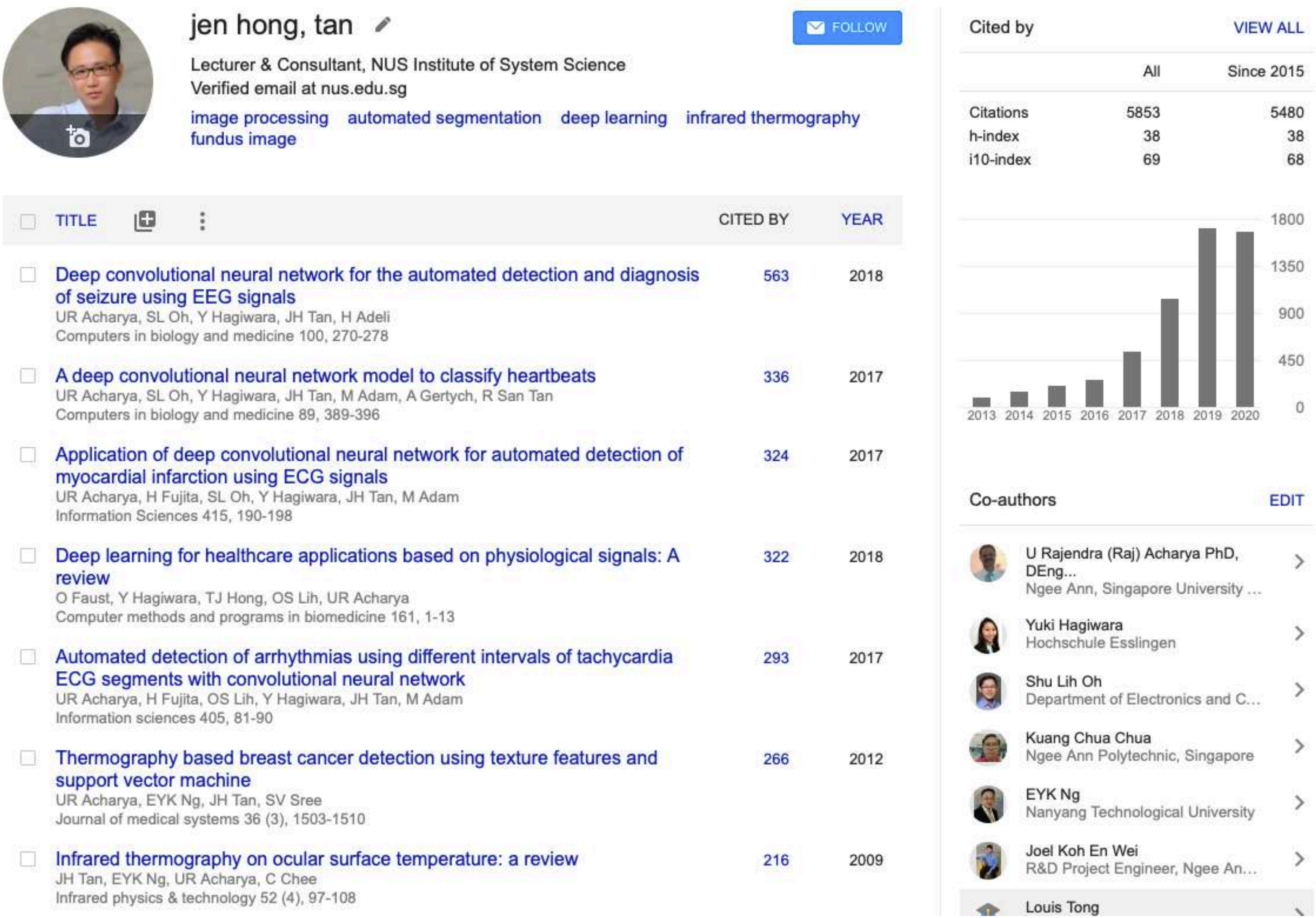

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image processing   automated segmentation   deep learning   infrared thermography   fundus image

□ TITLE	CITED BY	YEAR
□ Deep convolutional neural network for the automated detection and diagnosis of seizure using EEG signals UR Acharya, SL Oh, Y Hagiwara, JH Tan, H Adeli Computers in biology and medicine 100, 270-278	563	2018
□ A deep convolutional neural network model to classify heartbeats UR Acharya, SL Oh, Y Hagiwara, JH Tan, M Adam, A Gertych, R San Tan Computers in biology and medicine 89, 389-396	336	2017
□ Application of deep convolutional neural network for automated detection of myocardial infarction using ECG signals UR Acharya, H Fujita, SL Oh, Y Hagiwara, JH Tan, M Adam Information Sciences 415, 190-198	324	2017
□ Deep learning for healthcare applications based on physiological signals: A review O Faust, Y Hagiwara, TJ Hong, OS Lih, UR Acharya Computer methods and programs in biomedicine 161, 1-13	322	2018
□ Automated detection of arrhythmias using different intervals of tachycardia ECG segments with convolutional neural network UR Acharya, H Fujita, OS Lih, Y Hagiwara, JH Tan, M Adam Information sciences 405, 81-90	293	2017
□ Thermography based breast cancer detection using texture features and support vector machine UR Acharya, EYK Ng, JH Tan, SV Sree Journal of medical systems 36 (3), 1503-1510	266	2012
□ Infrared thermography on ocular surface temperature: a review JH Tan, EYK Ng, UR Acharya, C Chee Infrared physics & technology 52 (4), 97-108	216	2009

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Citations	5853	5480
h-index	38	38
i10-index	69	68

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Image segmentation

Active spline model

Active spline model: A shape based model-interactive segmentation

Learning objectives

- Read, display and write image
- Convert image’s colour format
- Expand image’s border
- Draw objects on image

Read image

- In opencv, use `imread()` to load an image

```
> import cv2

> imgfile = 'yoshida1.jpg'
> img     = cv2.imread(imgfile)
```

- Or simply just

```
> img     = cv2.imread('yoshida1.jpg')
```

- Supported formats: jpg, bmp, png, tif, tiff, pbm, ppm, hdr, pic
  - Check the below link for more detail: https://docs.opencv.org/3.4.2/d4/da8/group__imgcodecs.html

yoshida1.jpg

Check basic info

- Many times it is beneficial / required to check basic information about the image loaded

- In Spyder, that can be done in Variable explorer

```
                i     j
img | uint8 | (700, 477, 3)
              height width channel
                y     x
```

- To access through code, do

```
> img.shape
: (700, 477, 3)

> img.dtype
: dtype(‘uint8’)

> print('img height: %d' % (img.shape[0]))
: img height: 700
```

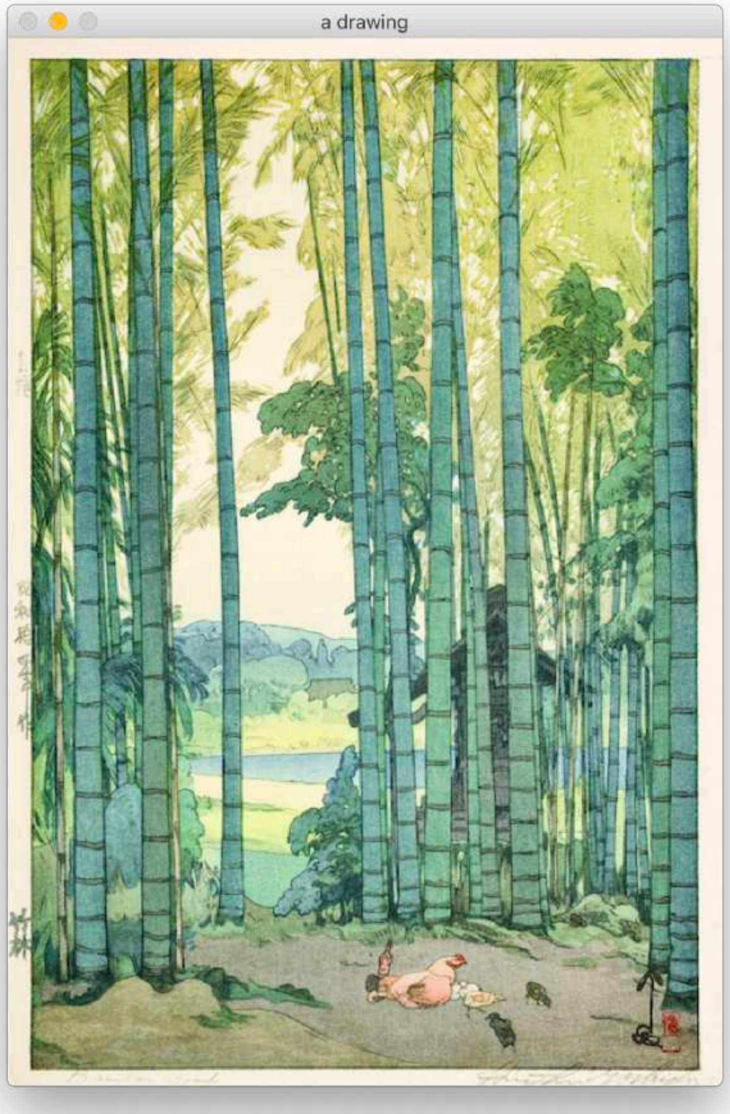
yoshida1.jpg

Display image

Through opencv

- To display an image in opencv for `img`, we do

```
> cv2.imshow('a drawing',img)
> cv2.waitKey(0)
> cv2.destroyAllWindows()
```



- On some platforms, it needs the below 4 lines to prevent freezing of the window:

```
> cv2.waitKey(1)
> cv2.waitKey(1)
> cv2.waitKey(1)
> cv2.waitKey(1)
```

Display image

Through opencv

```
> cv2.imshow('a drawing',img)
> cv2.waitKey(0)
> cv2.destroyAllWindows()
```

- `imshow()` does the display of image

```
cv2.imshow('a drawing',img)
```

name of the window

name of the variable

- `imshow()` should be followed by function `waitKey()`, which specifies how long the image should be specified in milliseconds

```
cv2.waitKey(0)
```

value zero stands for waiting infinitely

- `destroyAllWindows()` shuts down all windows opened through opencv

Colour format

BGR

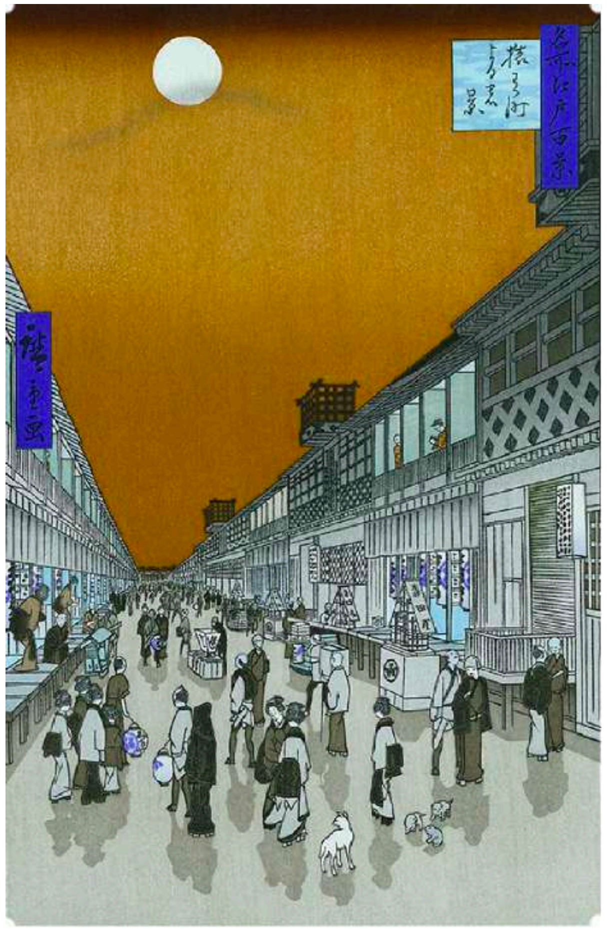
- The output of `imread()` is a numpy array

- This implies that we can manipulate the output variable using numpy's function/method

- For a colour image `img`, `imread()` gives a 3D numpy array, in BGR format

`img[:,:,0]`	→	**B**lue channel
`img[:,:,1]`	→	**G**reen channel
`img[:,:,2]`	→	**R**ed channel

- However, many other libraries process image array only in RGB format



BGR format displayed by function that expects RGB format

Colour format conversion

- Use `cvtColor()` to convert colour format

name of the variable

```
> imgc = cv2.cvtColor(img,
                      cv2.COLOR_BGR2GRAY)
```

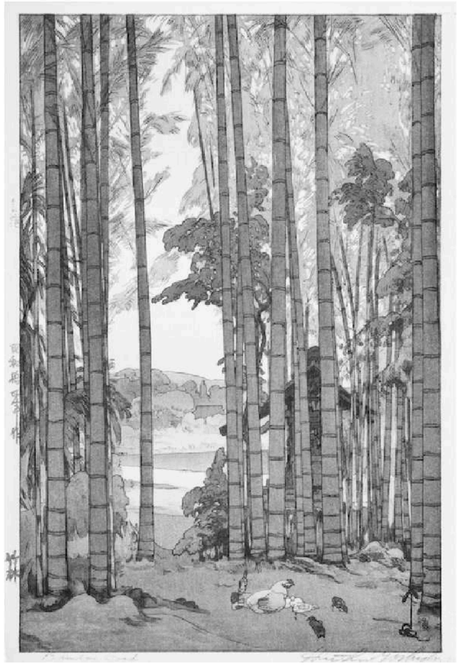
colour conversion code

- Other conversion codes:

```
cv2.COLOR_GRAY2BGR
cv2.COLOR_RGB2BGR
cv2.COLOR_BGR2RGB
cv2.COLOR_BGR2YUV
cv2.COLOR_YUV2BGR
cv2.COLOR_BGR2Luv
cv2.COLOR_Luv2BGR
...
```

- Check the below link for more detail

  https://docs.opencv.org/3.4.2/d7/d1b/group__imgproc__misc.html



Colour format conversion

- When we convert a colour image to gray, the output is no longer a 3D numpy array

```
> imgc.shape
: (700, 477)
```

- To get back a 3D BGR array, we can do

```
> imgd = cv2.cvtColor(imgc,
                      cv2.COLOR_GRAY2BGR)
```

- Or we can do

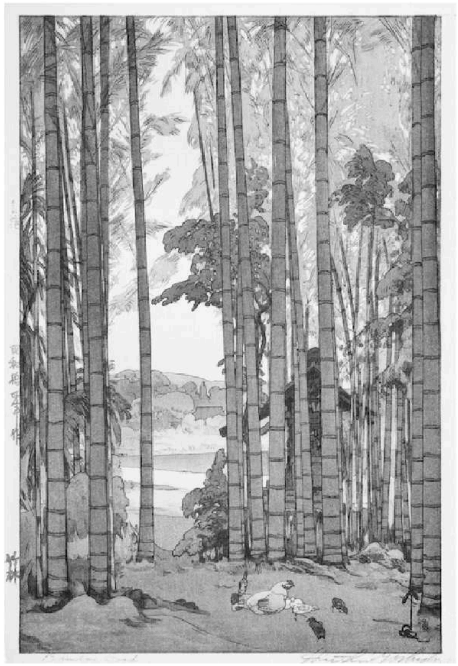
for blue channel

for red channel

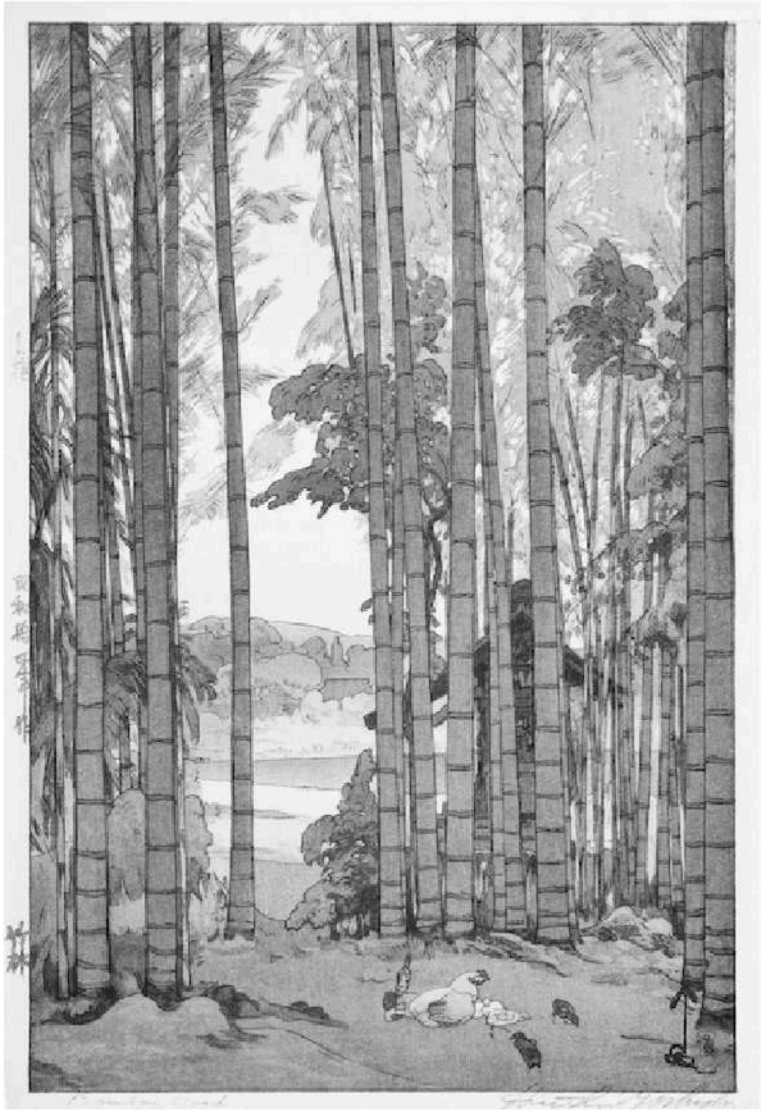
```
> imge = cv2.merge((imgc,imgc,imgc))
```

for green channel

A gray is simply a colour that has the same value in R,G and B

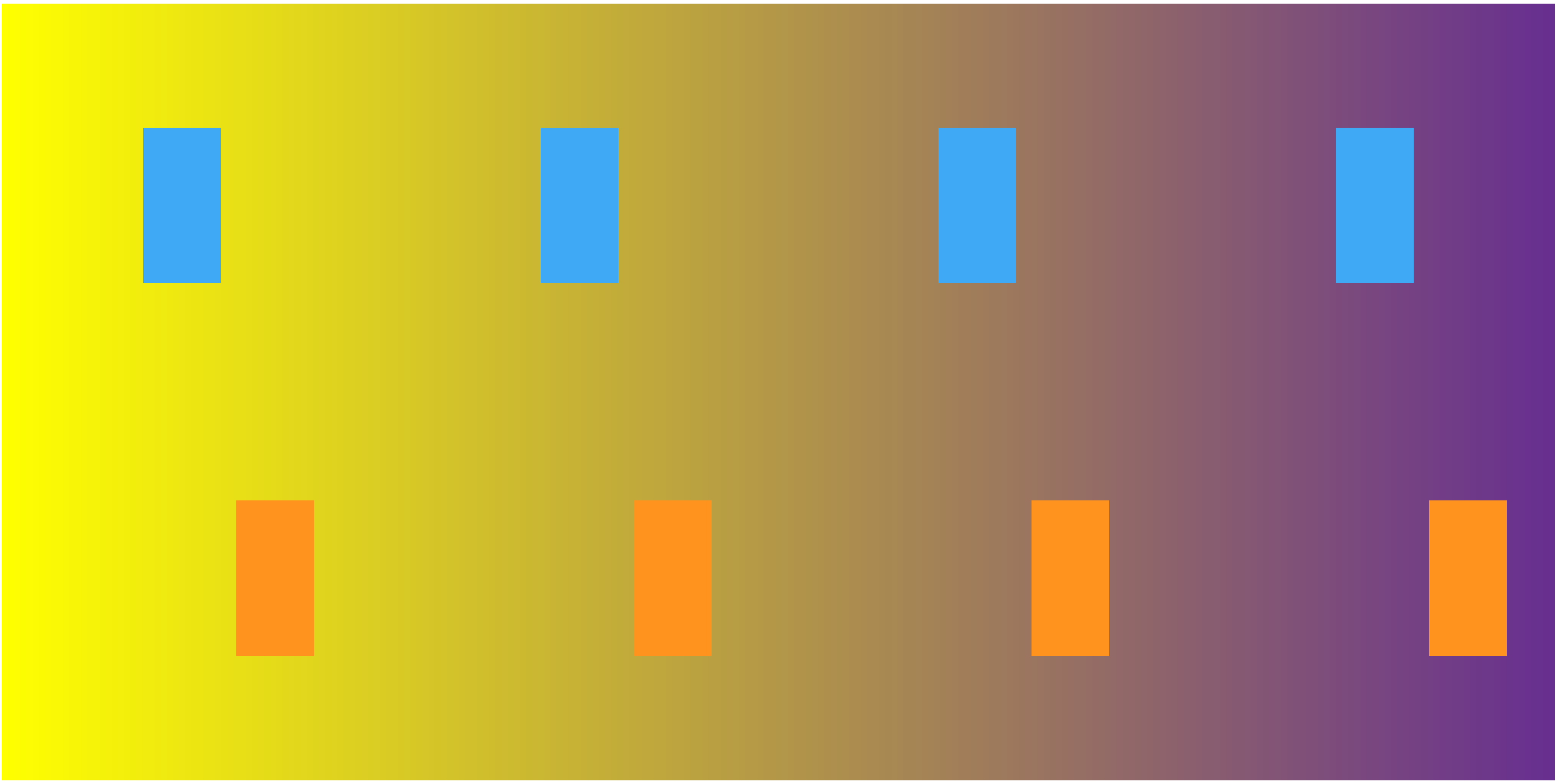


Why often do we need to convert colour image into gray scale image?

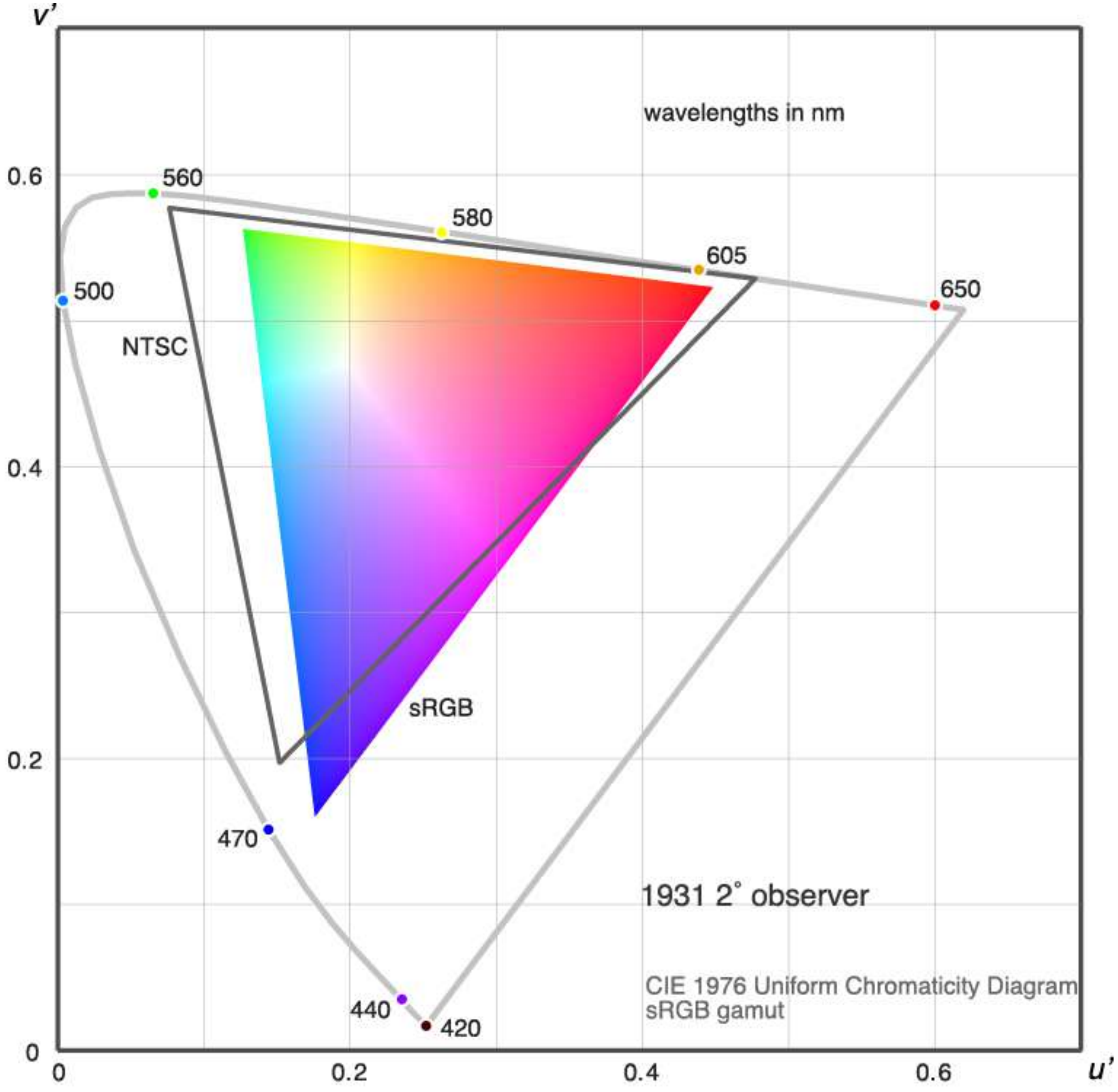


Something about colour …

- Illustration of simultaneous colour contrast



The theory of colour



Display image, again

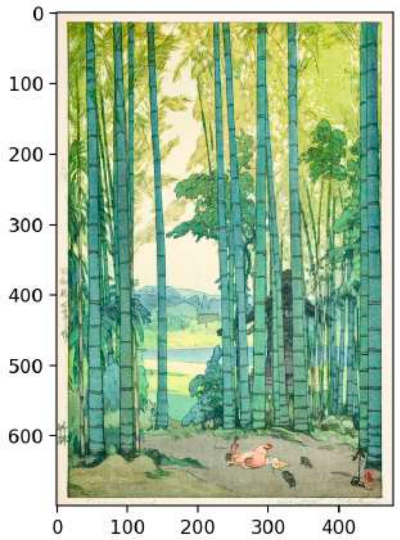
Through matplotlib

- We can use matplotlib to display an image `img`, to do that, we write

```
> import matplotlib.pyplot as plt
> plt.axis('off')
> plt.imshow(cv2.cvtColor(img,
                        cv2.COLOR_BGR2RGB))
> plt.show()
```

- In the above codes, we first turn off axis in the plot
- Then use `plt.imshow()` to display image, but that function expects image in RGB format
- Thus need to use `cv2.cvtColor()` to convert `img` into RGB format
- Finally, use `plt.show()` to get the plot displayed

axis on



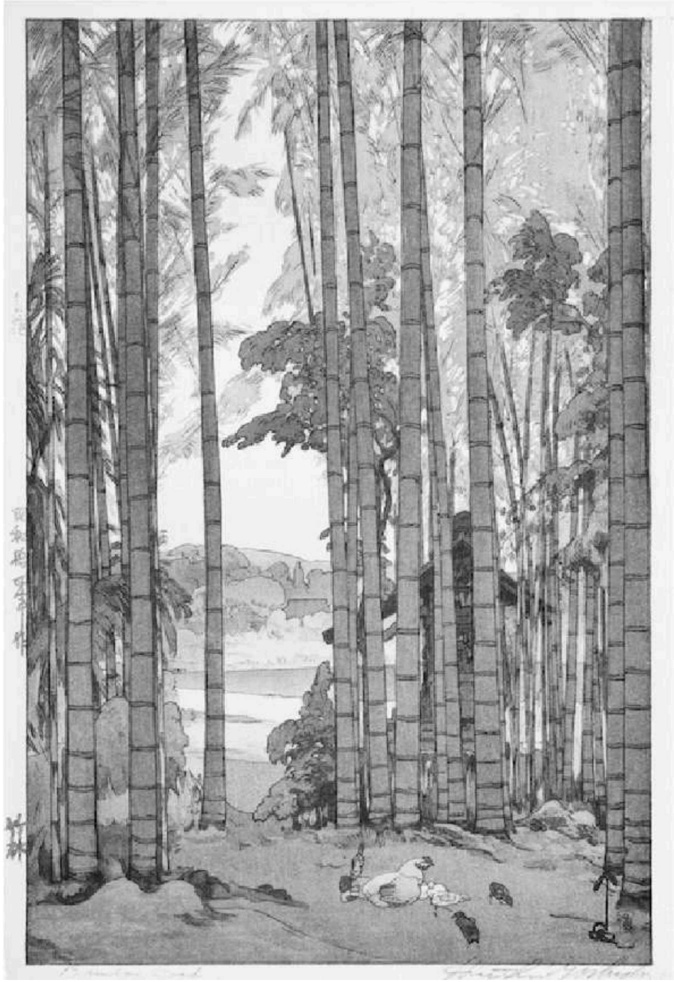
axis off

Display image, again

Through matplotlib

- To display a grayscale image `imgc`, we need extra settings on `plt.imshow()`

```
> plt.axis('off')
> plt.imshow(imgc,
             cmap='gray',
             vmin=0,
             vmax=255)
> plt.show()
```

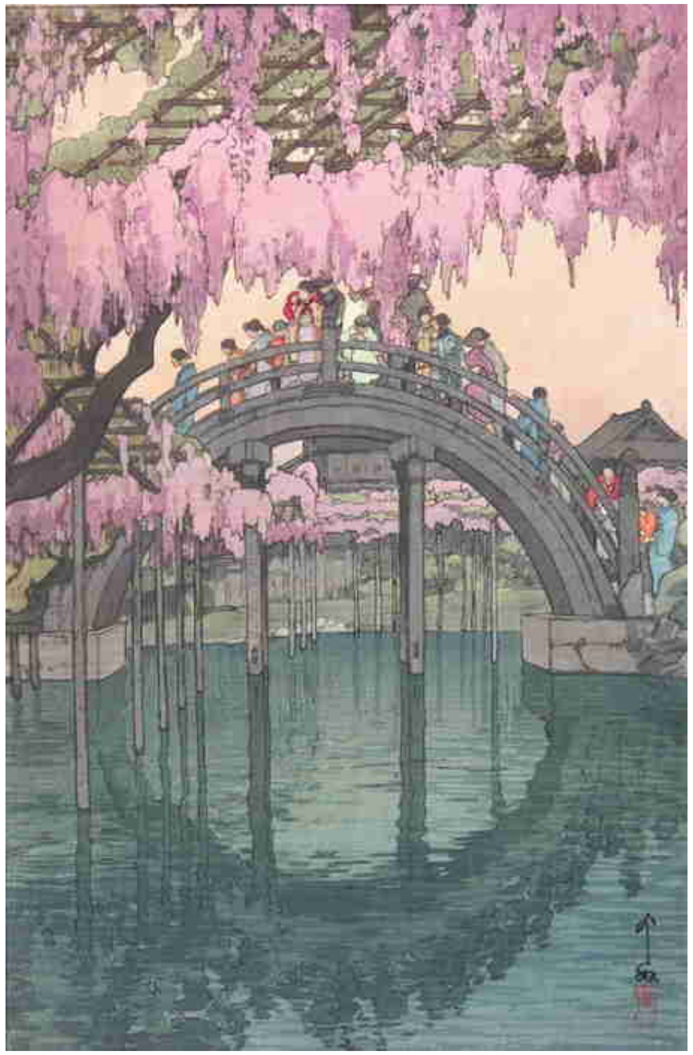


- `cmap='gray'` : inform the function to use grayscale colour map
- `vmin=0` : map value 0 to black
- `vmax=255` : map value 255 to white

Expand image border

- Often in image processing it is necessary to expand image border to avoid undesired effect

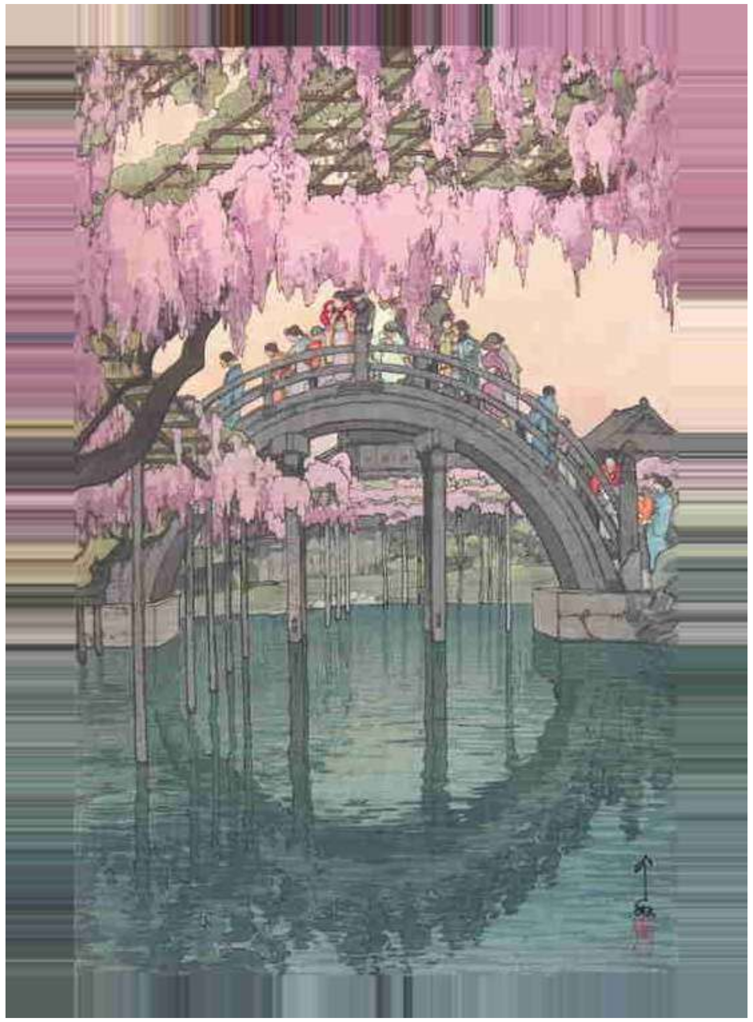
- Use cv2.copyMakeBorder() to expand border



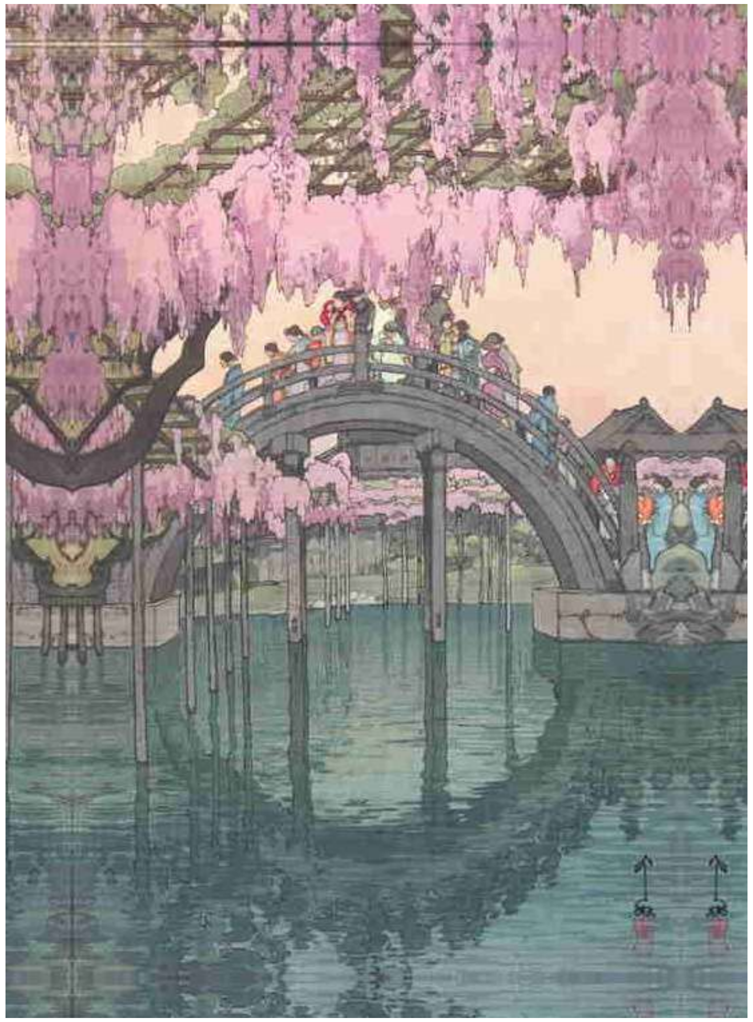
```
> imgf = cv2.imread('yoshida2.jpg')
> bdrx = cv2.copyMakeBorder(imgf,
                            30,    top
                            30,    bottom
                            50,    left
                  right     50,
             borderType     cv2.BORDER_REPLICATE)
```

Expand image border

`cv2.BORDER_REPLICATE`

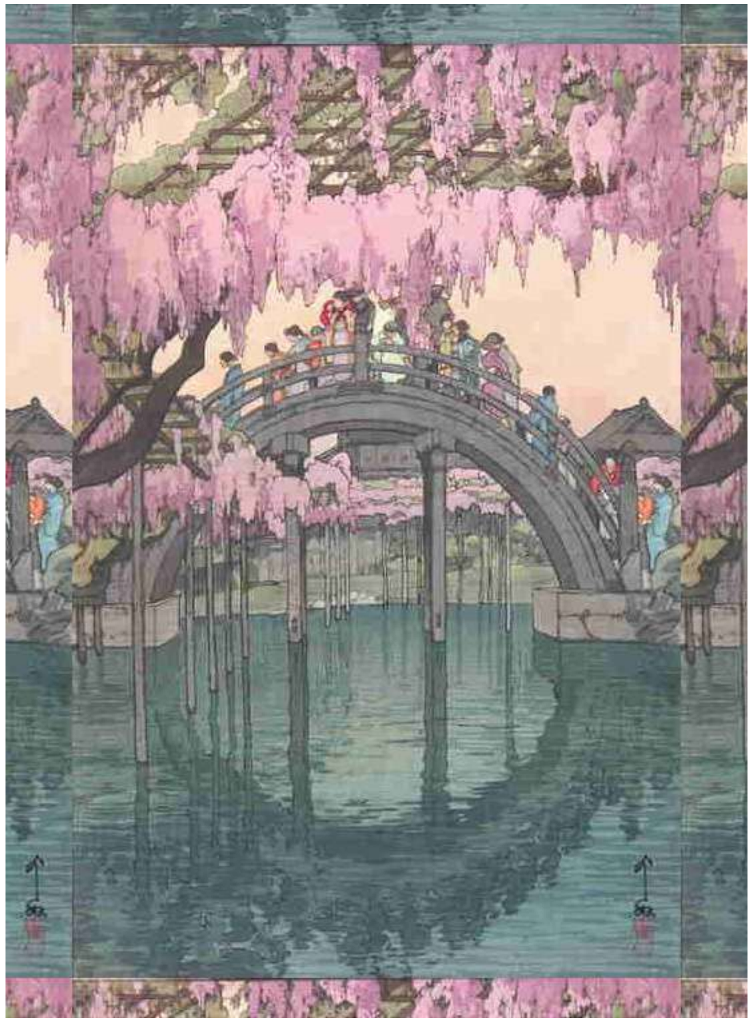


`cv2.BORDER_REFLECT`

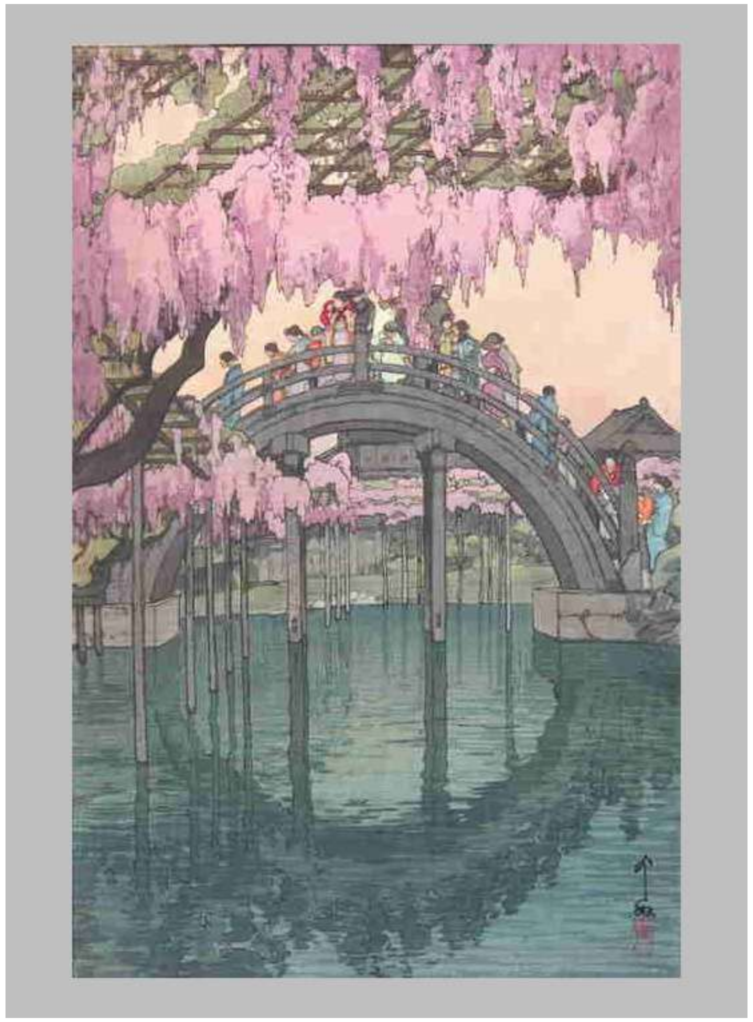


Expand image border

`cv2.BORDER_WRAP`



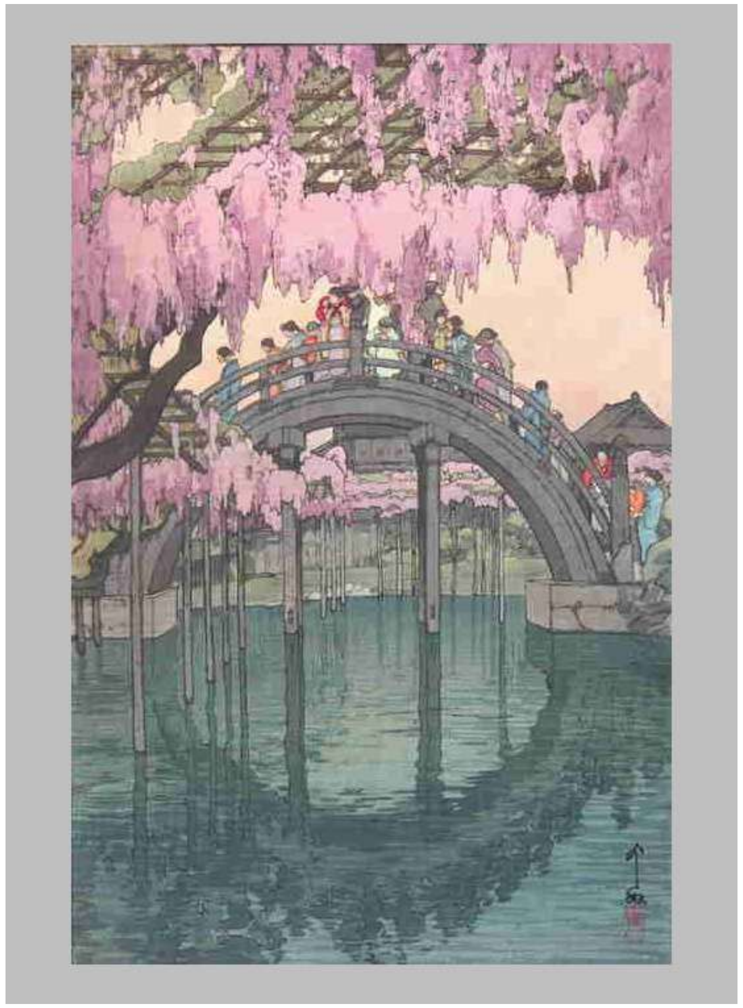
`cv2.BORDER_CONSTANT`



Expand image border

- When we select borderType `cv2.BORDER_CONSTANT`, we need to input one extra parameter:

- The colour we want on the border



```
> bdrx = cv2.copyMakeBorder(imgf,
                                  30,     top
                                  30,     bottom
                                  50,     left
                     right        50,
                borderType        cv2.BORDER_CONSTANT,
                    colour        value=(191,191,191))
                                         B   G   R
```

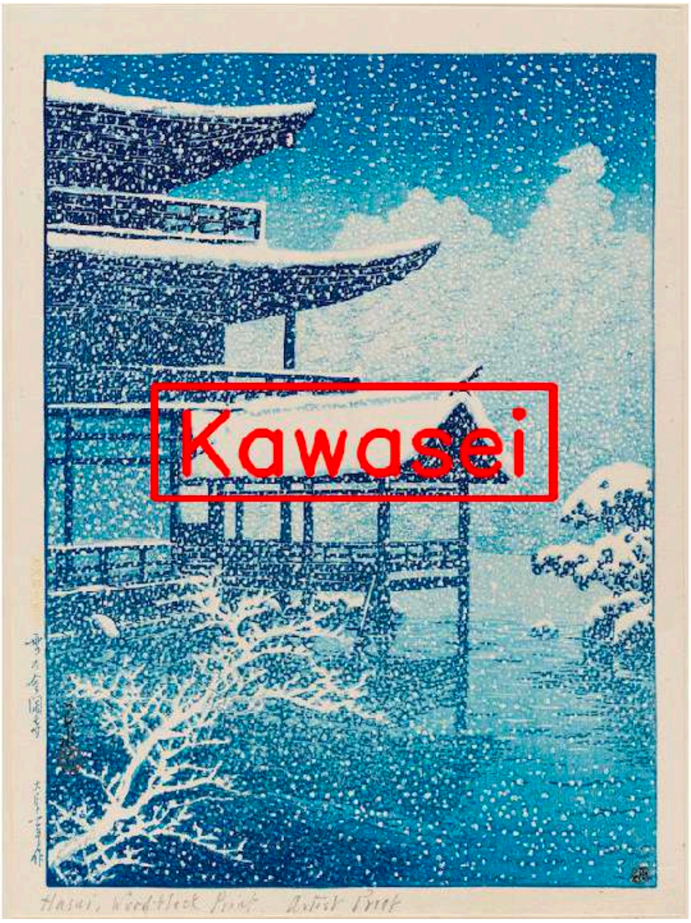
Draw objects

- We can draw objects on image using API provided by opencv

- Generally in computer vision we use these API to make annotations on image

- Some of the functions available:

```
cv2.line()
cv2.circle()
cv2.rectangle()
cv2.ellipse()
cv2.putText()
…
```



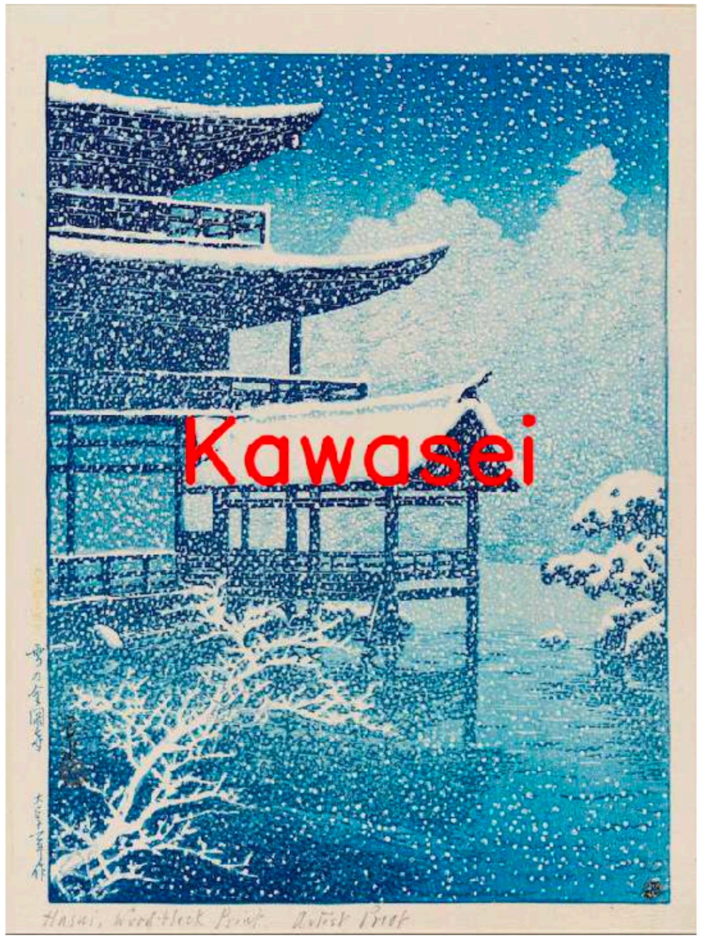
- After the drawing, we display the product either using `cv2.imshow()` or `plt.imshow()`

Draw text

- To write words on image, we use `cv2.putText()`

```
                                > imgg = cv2.imread('kawasei1.jpg')

                                > cv2.putText(imgg,
                                              'Kawasei',   text to display
(x, y) position at bottom-left                (150,410),
                     font type                cv2.FONT_HERSHEY_SIMPLEX,
                    font scale                2.5,
                        colour                (0,0,255),
                font thickness                5,
                     line type                cv2.LINE_AA)
```



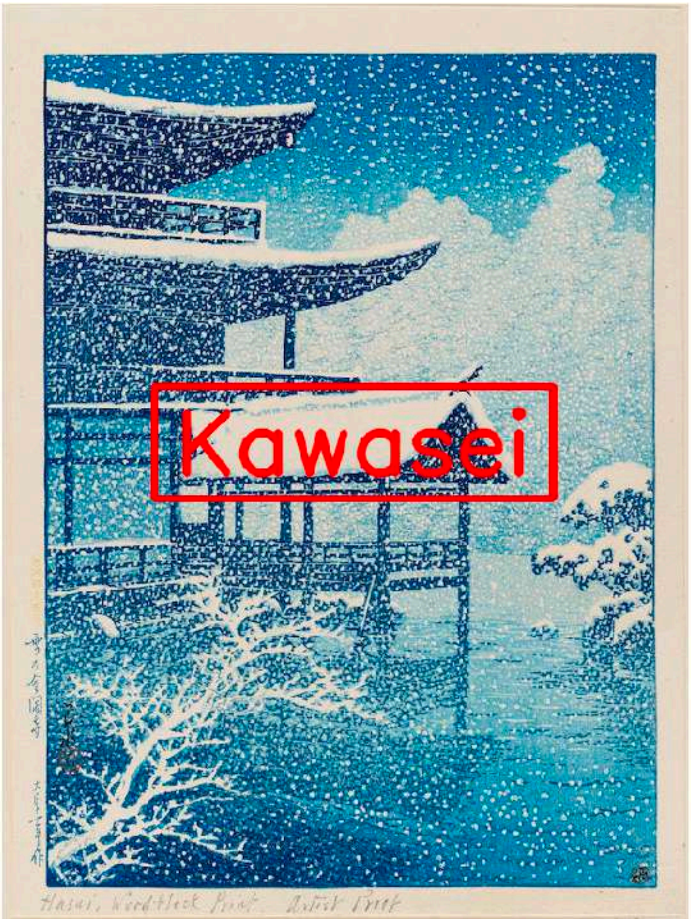
- `cv2.FONT_HERSHEY_SIMPLEX` stands for normal size sans-serif font

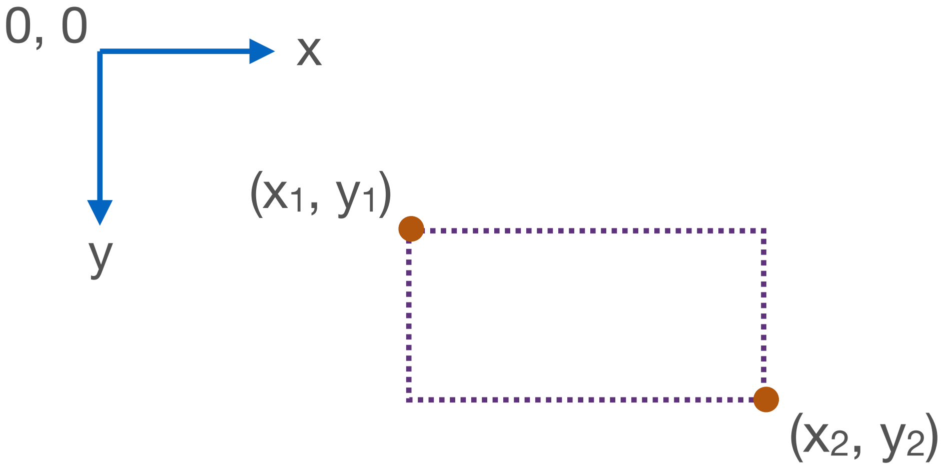
- `cv2.LINE_AA` gives anti-aliased line

Draw rectangle

- To draw rectangle on image, we use `cv2.rectangle()`

```
> cv2.rectangle(imgg,
                          (132,334),  (x1, y1)
             (x2, y2)     (480,432),
               colour     (0,0,255),
            thickness     5)
```





Saving image

- After all the hard work, it would be useless if we can't save the final output

- To save an image, we use `cv2.imwrite()`

```
> cv2.imwrite('kawas.jpg',  file name
     variable  imgg)
```

- Supported formats: jpg, png, tif, tiff, hdr, exr
  - Check the below link for more detail: https://docs.opencv.org/3.4.2/d4/da8/group__imgcodecs.html