Introduction to OpenCV

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What is OpenCV?

- Image/video processing library created at Intel Labs in the late 1990’s.
- Written in C++, bindings in Java, Python, Matlab/Octave, JS.
- Cross-platform (Windows, Mac, Linux, Android, iOS, RaspberryPi).
- Open source (BSD).
- This course: **Python, Windows, version 4.0.0**

Highlights

- Object detection and recognition (facial, gesture, etc).
- Video/image processing.
- Robotics (good integration with ROS).
- Machine learning support (including neural networks and deep learning!).

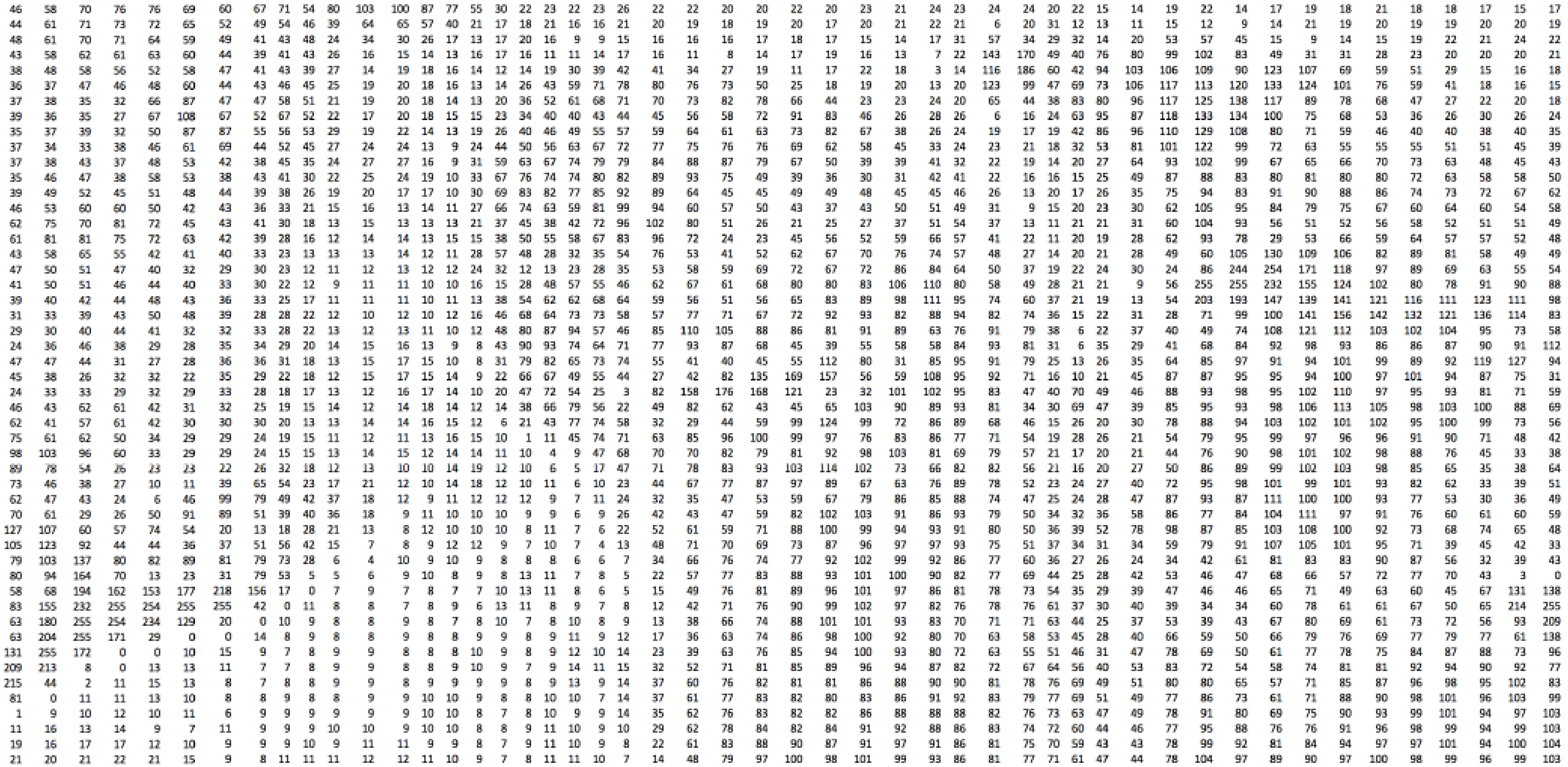
Installing OpenCV

- Download and install Anaconda for Python 3.+

- Create a virtual environment, activate and install:
  - `conda create –n opencv python=3.7`
  - `conda activate opencv`
  - `pip install opencv-contrib-python`

Getting Started

- Basic I/O for images. **What is an image?**
- Integration with numpy/matplotlib and friends.
- Basic I/O for video.
- Operations on images.



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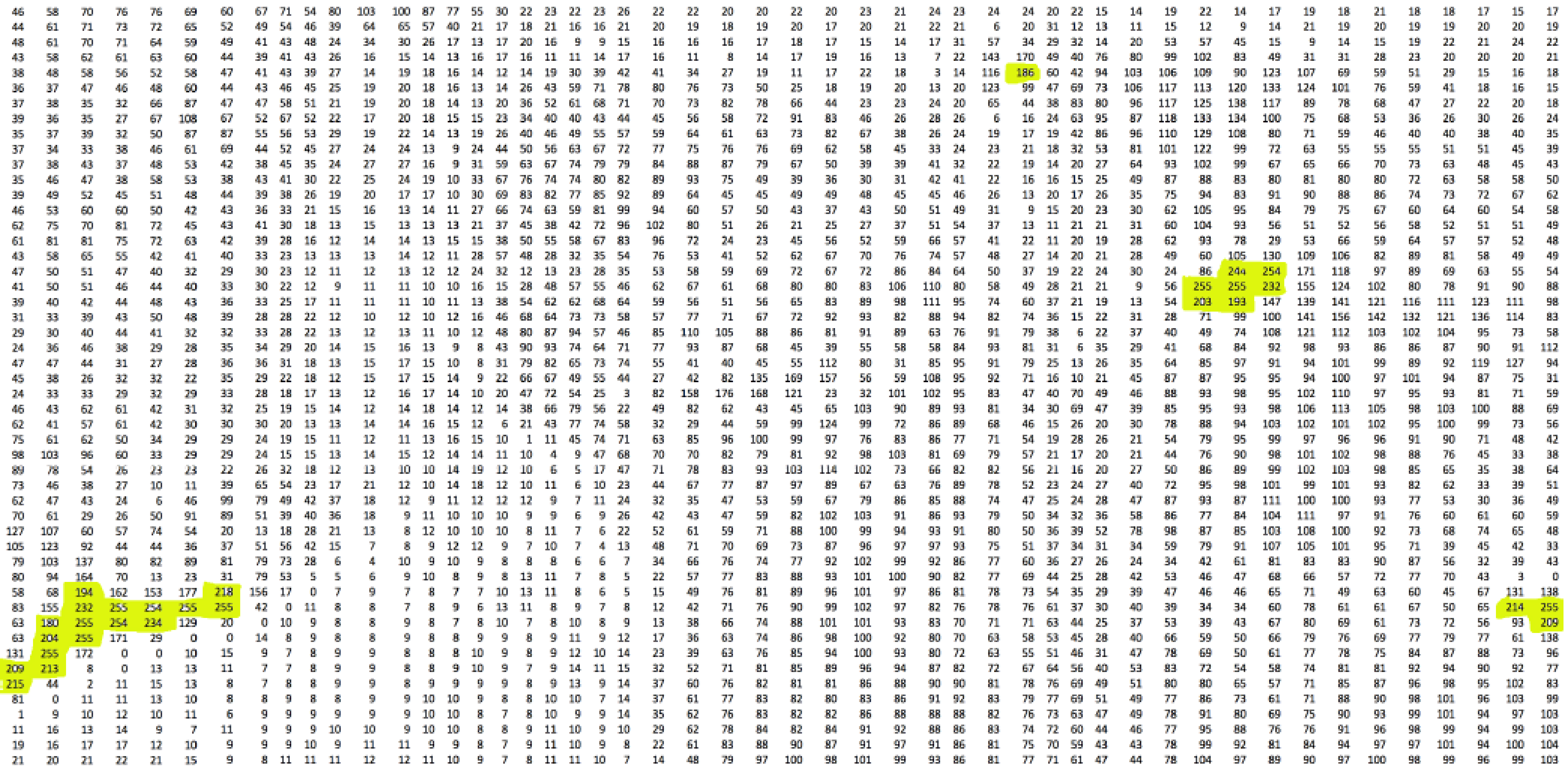

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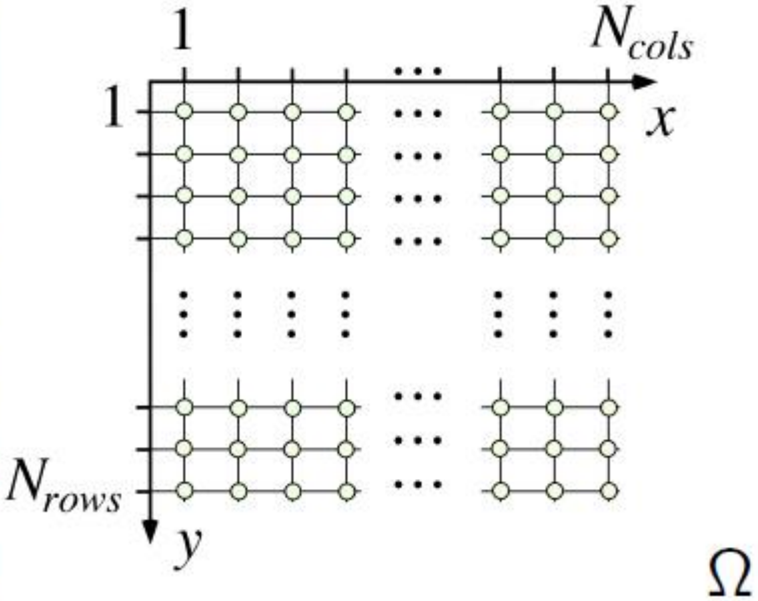

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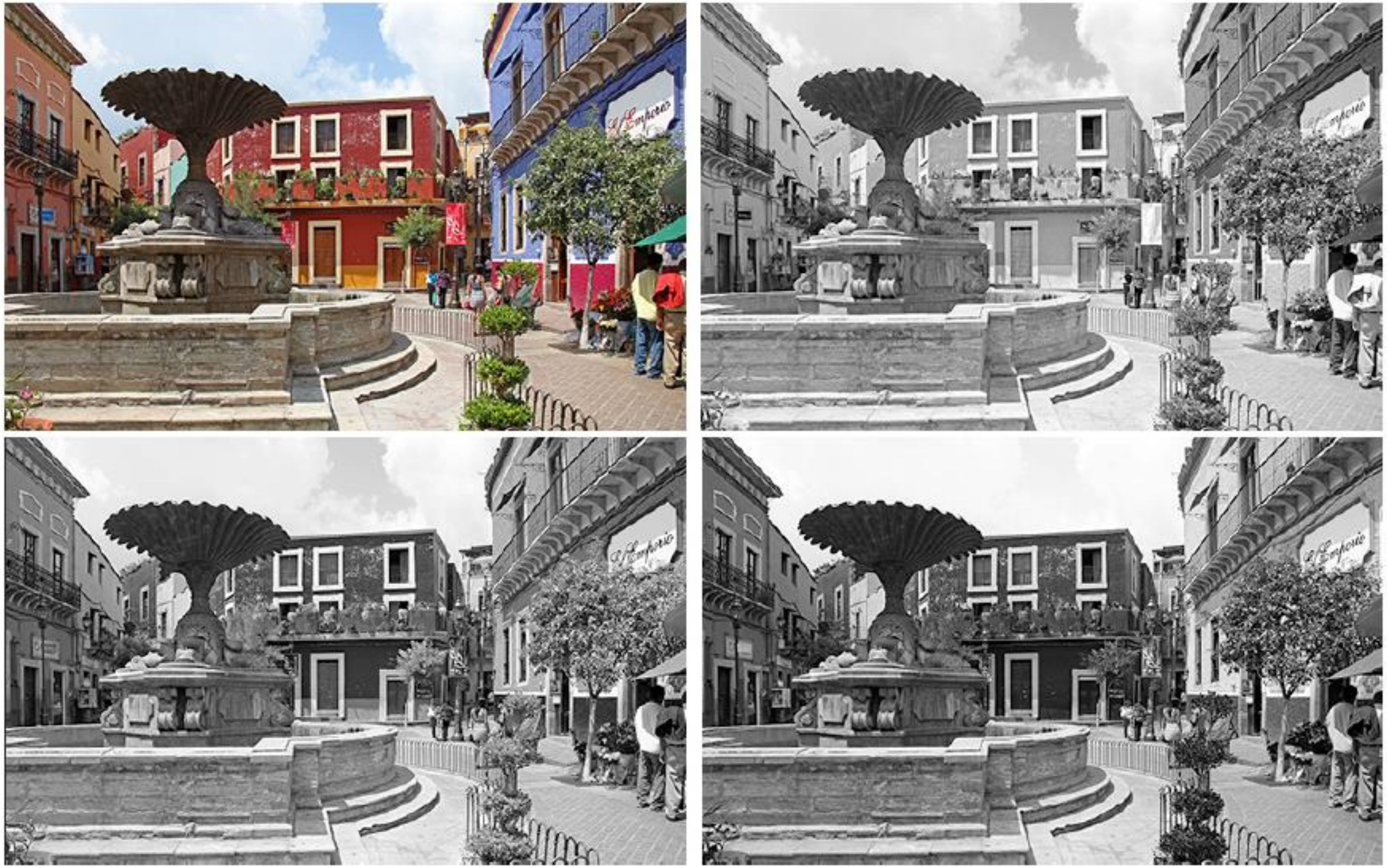

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Demo

NOTEBOOKS 1.1 AND 1.2

C++ vs Python API

OpenCV modules

- core. Core functionality
- imgproc. Image Processing
- highgui. High-level GUI
- video. Video Analysis
- calib3d. Camera Calibration and 3D Reconstruction
- objdetect. Object Detection
- dnn. Deep Neural Network module
- ml. Machine Learning
- flann. Clustering and Search in Multi-Dimensional Spaces
- photo. Computational Photography
- stitching. Images stitching
- gapi. Graph API
- features2d. 2D Features Framework

Plus many other extras!

https://docs.opencv.org/4.0.0/

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- **core**. Core functionality
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Main differences

- The C++ version has its own data structures for matrices/vectors. The Python version uses numpy arrays.

- In Python, cv used to keep the C++ data structures, and cv2 was the numpy version. Now cv is gone, but confusingly, the name stays in the documentation.

- Python functions **mostly** do not modify the input.
  - **Notable exceptions:** findCountours in older versions (3.2 and below), drawing functions.

Main differences

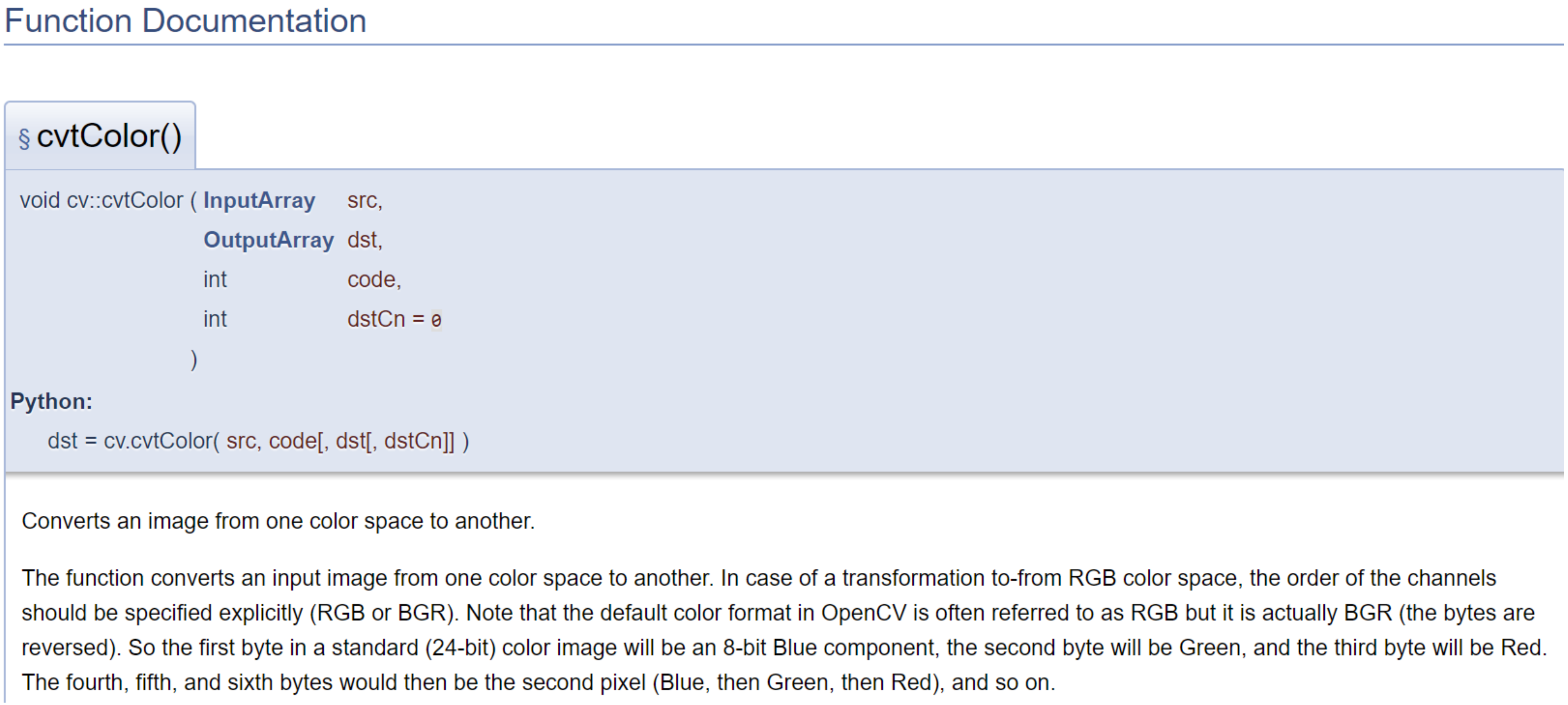
- Numpy arrays ➔ OpenCV C++ objects ➔ Numpy arrays. Not a huge performance loss unless your code uses a lot of Python-specific features.

- No modules in Python. Everything lives in cv2.

- It is possible to extend new modules to Python, see OpenCV docs, last chapter.

- **Occasional issues with Python bindings:** as of March 2019, ORB and Stitcher API (Panorama pictures) not working.

Example



Function Documentation

§ cvtColor()

```
void cv::cvtColor ( InputArray   src,
                    OutputArray  dst,
                    int          code,
                    int          dstCn = 0
                  )
```

Python:

```
dst = cv.cvtColor( src, code[, dst[, dstCn]] )
```

Converts an image from one color space to another.

The function converts an input image from one color space to another. In case of a transformation to-from RGB color space, the order of the channels should be specified explicitly (RGB or BGR). Note that the default color format in OpenCV is often referred to as RGB but it is actually BGR (the bytes are reversed). So the first byte in a standard (24-bit) color image will be an 8-bit Blue component, the second byte will be Green, and the third byte will be Red. The fourth, fifth, and sixth bytes would then be the second pixel (Blue, then Green, then Red), and so on.