# Multimedia Retrieval Exercise Course

## 2 Basic Knowledge about Images in OpenCV

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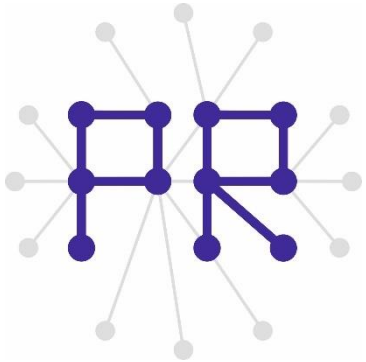


# Code in the Last lesson

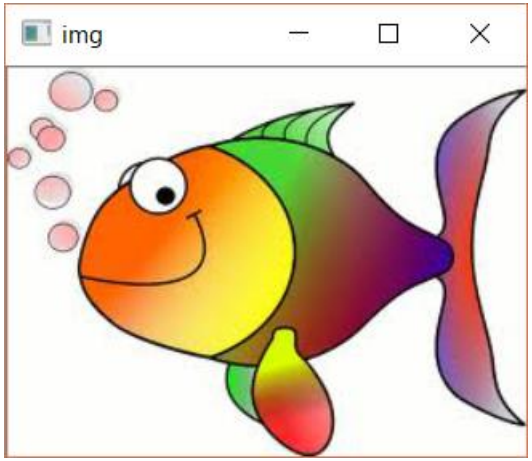
- Read an image and show it in a dialog

```
#include "stdafx.h“ // This is a head file specific to my project

#include <opencv2/core.hpp>
#include <opencv2/highgui.hpp>

int main(int argc, const char* argv[]){
   cv::Mat img = cv::imread("C:\\opencv\\sources\\samples\\data\\HappyFish.jpg", 1);
   cv::namedWindow("img", cv::WINDOW_AUTOSIZE);
   cv::imshow("img", img);
   cv::waitKey(0);
   cv::destroyAllWindows();
   return 0;
}
```

Please change the image filename depending on your environment.



# Overview of Today's Lesson

1. cv::Mat
    - Structure of cv::Mat
    - Printing out the Header Information
    - How are pixel values stored with cv::Mat
    - Printing out Pixel Values
    - Shallow and deep copies

2. Useful functions in highgui

# OpenCV Information

Useful web page: https://opencv.org/releases.html
(Especially, https://docs.opencv.org/3.3.0/)

opencv2/

- core.hpp: Basic data structure and functions in OpenCV
- imgproc.hpp: Functions for image processing and analysis
- imgcodecs.hpp: Functions for loading and writing image files
- videoio.hpp: Functions for loading and writing video files
- highgui.hpp: Functions for creating and managing GUIs
  (highgui.hpp includes core.hpp, imgcodecs.hpp and videoio.hpp)

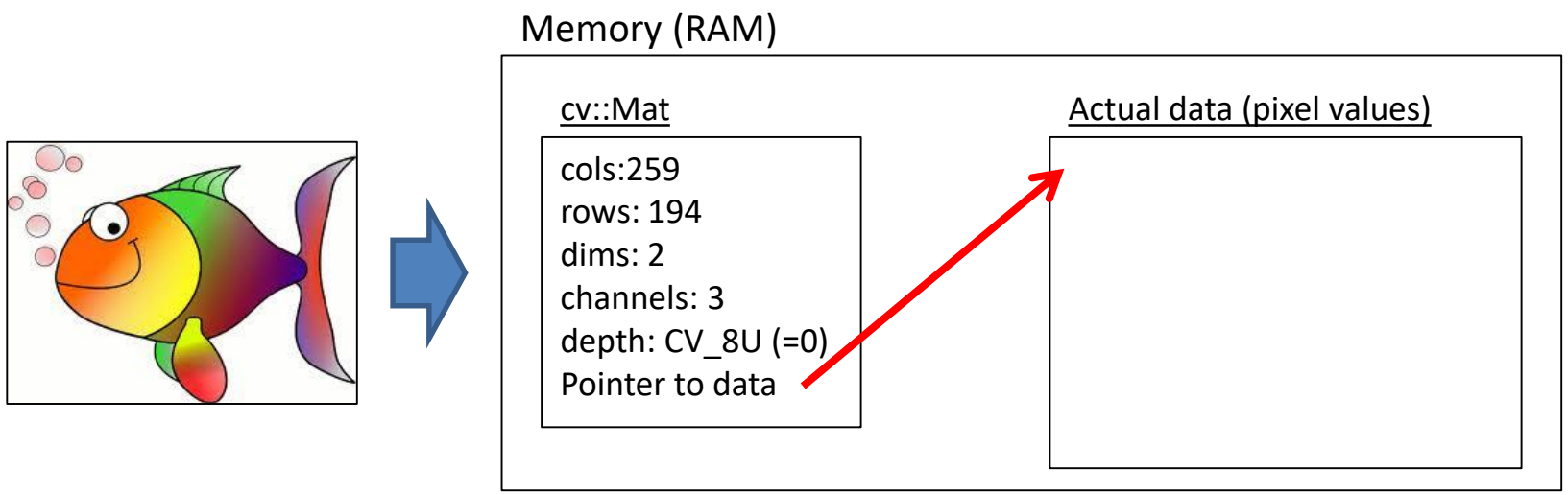
- ml.hpp: Functions for machine learning methods
- dnn.hpp: Functions for deep learning methods

etc.

# cv::Mat

Container for storing an image

- **Data header**
  - cols: Image width
  - rows: Image height
  - dims: Number of dimensions
    (An image has 2 dimensions corresponding to the row and column)
  - channels: Number of channels used to represent a pixel
    (3 channels for an RGB image, 1 channel for a gray-scale image)
  - depth: Data type used to represent one channel
    (A usual image where the R/G/B value of a pixel range from 0 to 255.
    This means one channel is represented by “8-bit unsigned char (integers)”)
- **Pointer to data**



# Printing out the Header Information

Please add to the last lesson's code some sentences to show image's width, height, dimensionality, channels and depth.

The code will be released after the lesson

1. Please refer to https://docs.opencv.org/3.3.0/d3/d63/classcv_1_1Mat.html for how to access each piece of information.

2. To output texts to a terminal, "cout" in C++ is more convenient than "printf" because the former can automatically recognise the variable types.

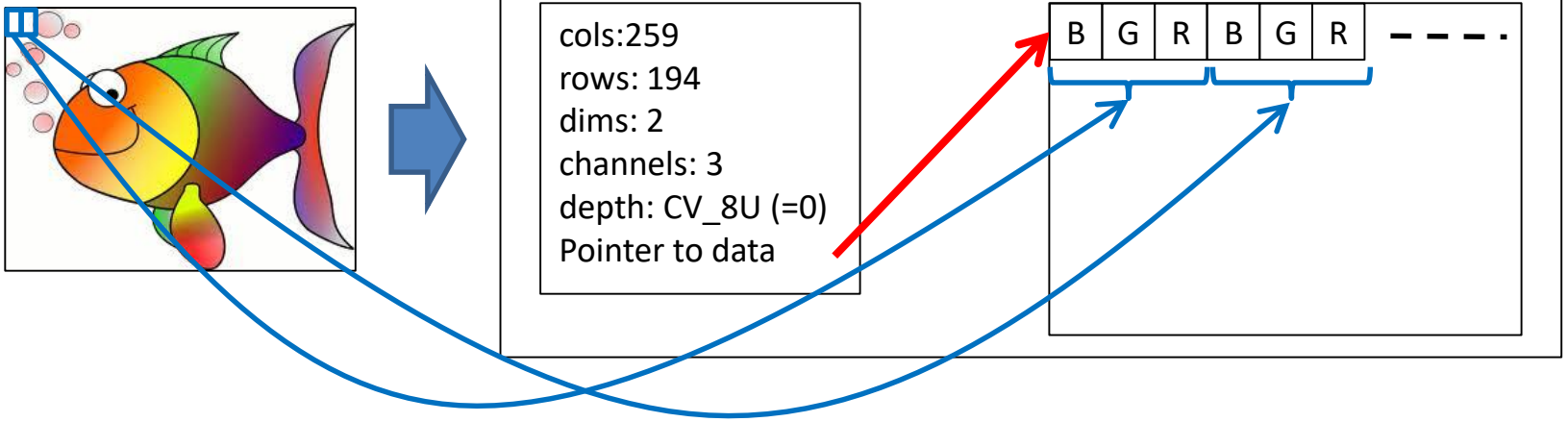
```
#include <iostream>
using namespace std; // If this is missing, "cout" has to be written as "std::cout"
```

3. In Visual C++, a terminal will quickly disappear after reaching the end of a program. To keep the terminal appearing, one simple approach is as follows:

```
int a = 0;
cin >> a;  // Wait until some value is input into "a"
```

# cv::Mat in More Detail

3-channel color image




Each pixel with three channels is represented by three values (*the order is BGR*)

For 8-bit depth images, it is recommended to access one pixel ( B G R ) using cv::Vec3b.

- Get the values of the pixel (x, y)

  cv::Vec3b p = img.at<cv::Vec3b>(y, x);

  Then, B, G and R values of (x, y) are p[0], p[1] and p[2], respectively.

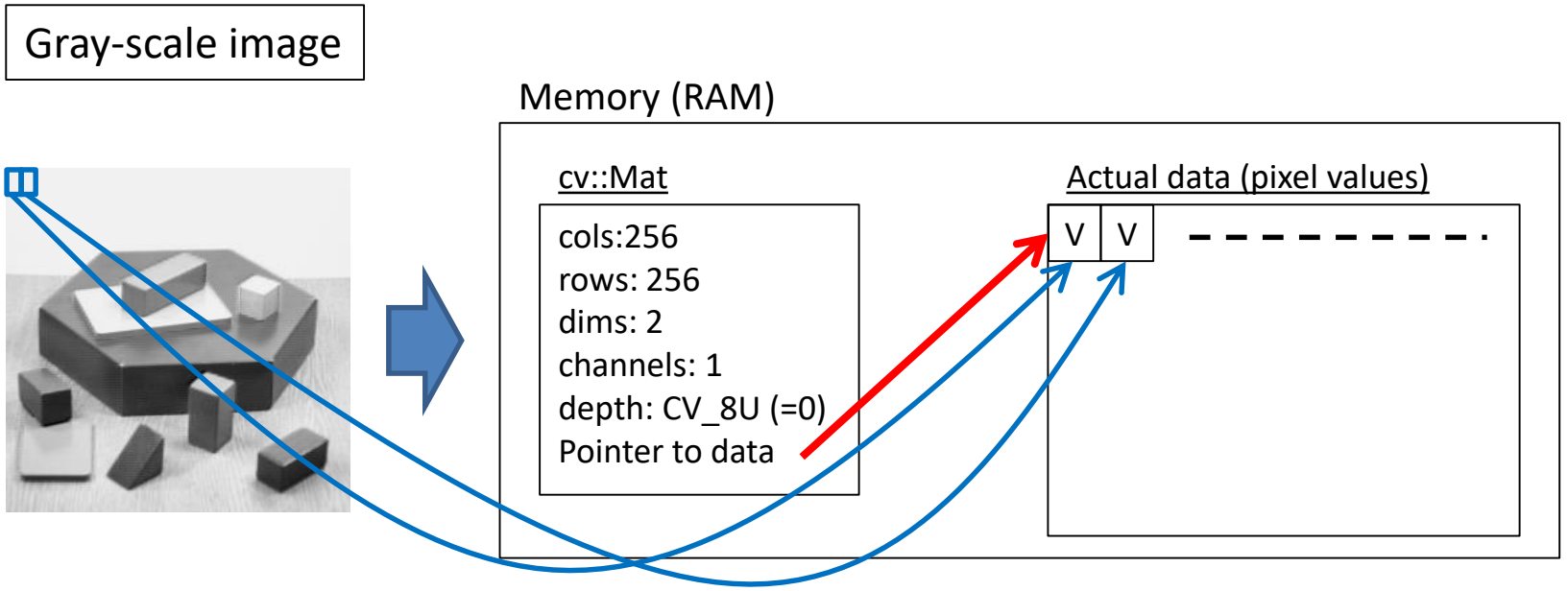
- Get the pointer to the yth row

  cv::Vec3b *row = img.ptr<cv::Vec3b>(y);

  Then, B, G and R values of (x, y) are row[x][0], row[x][1] and row[x][2], respectively.

For another depth image, refer to https://docs.opencv.org/3.3.0/dc/d84/group__core__basic.html

# For Your Information




Each pixel has only one channel value ( V )

For 8-bit depth images, it is recommended to access one pixel using uchar.

- Get the values of the pixel (x, y)

```
uchar p = img.at<uchar>(y, x);
```

- Get the pointer to the yth row

```
uchar *row = img.ptr<uchar>(y);
```

Then, the value of (x, y) are row[x].

# Printing out Pixel Values

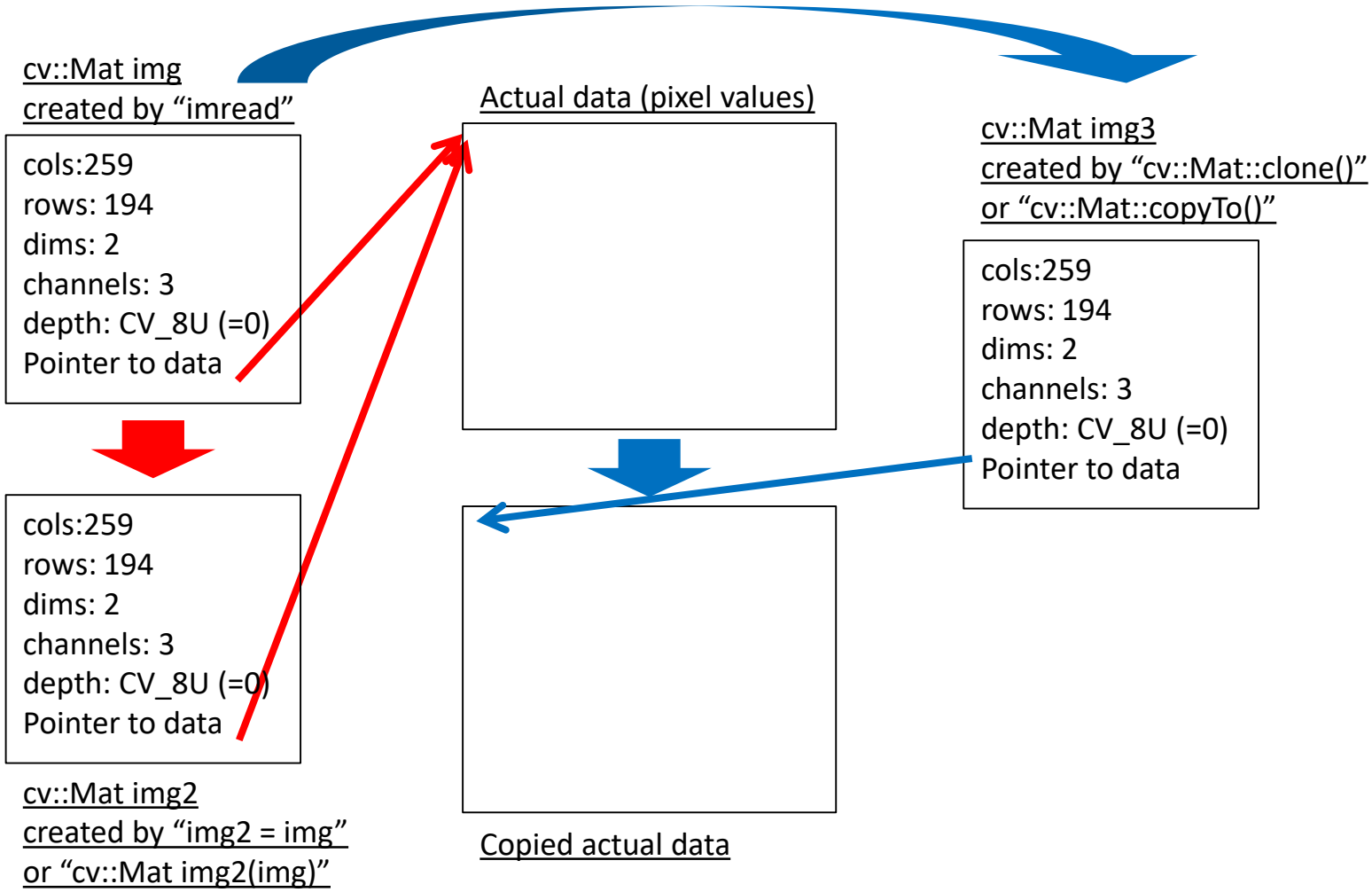
Please add to the last lesson's code sentences to show the values of each pixel

The code will be released after the lesson

**NOTE:** Variable type recognition of "cout" does not work for elements (unsigned char) of Vec3b. Use "printf" to show pixel values.

# Shallow and Deep Copies

- **Shallow copy:** Only the header is copied
- **Deep copy:** Both of the header and actual data are copied



# Useful Functions in highgui

**1. void cv::namedWindow(const String &winname, int flags=WINDOW_AUTOSIZE)**
The first variable specifies the name of the window where an image is shown.

**2. void cv::imshow(const String &winname, InputArray mat)**
Using the first variable, you can specify which window is used to show an image (mat)

**3. void cv::destroyAllWindows(), void cv::destroyWindow(const String &winname)**
Release the memory used for the window

**4. int cv::waitKey (int delay=0)**
The function is used to wait for some key input or “delay” milliseconds.
The return value represents which key is pressed.

For more detail, refer to https://docs.opencv.org/3.3.0/d7/dfc/group__highgui.html