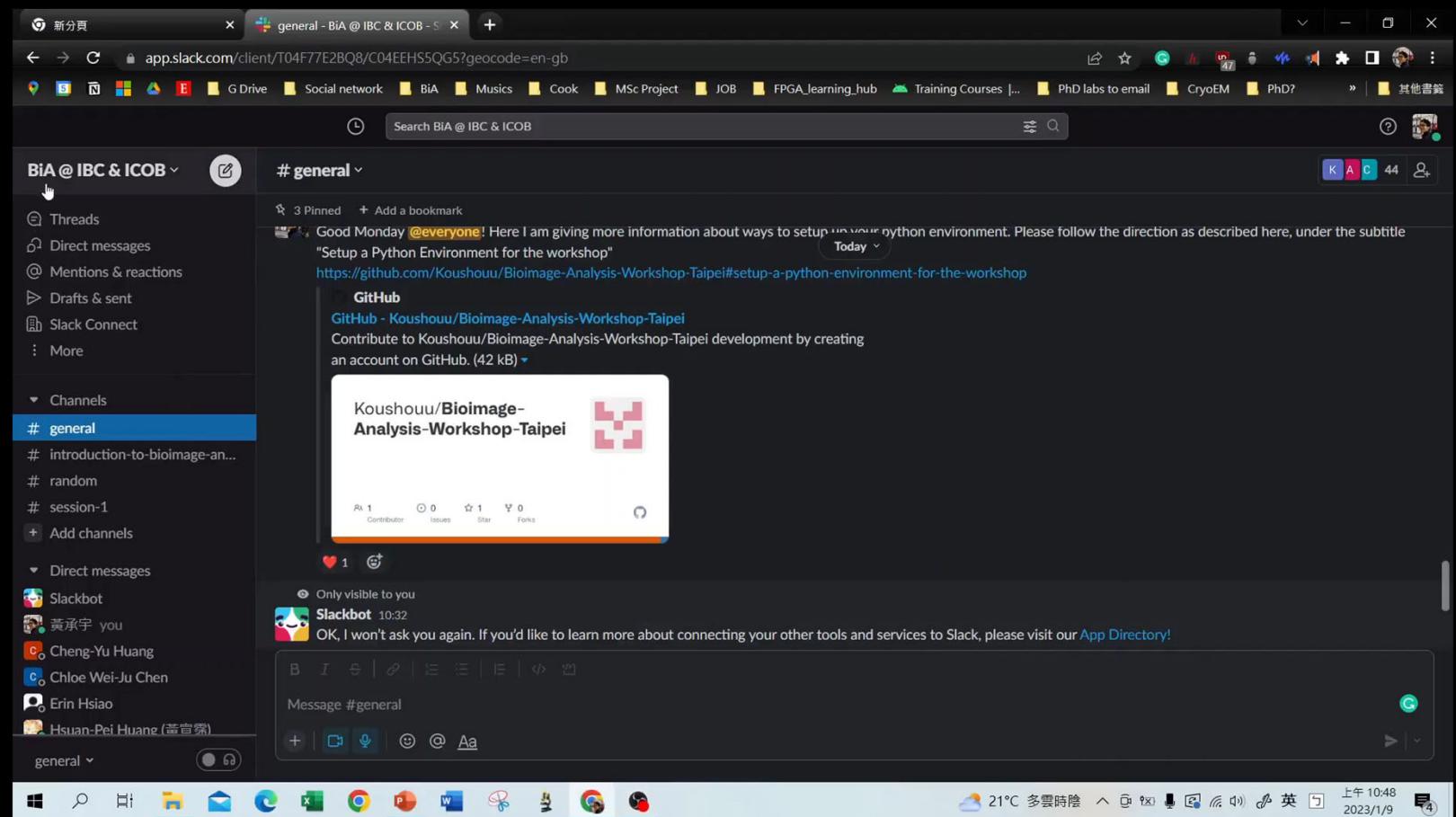


Starting soon...

What you can do right now

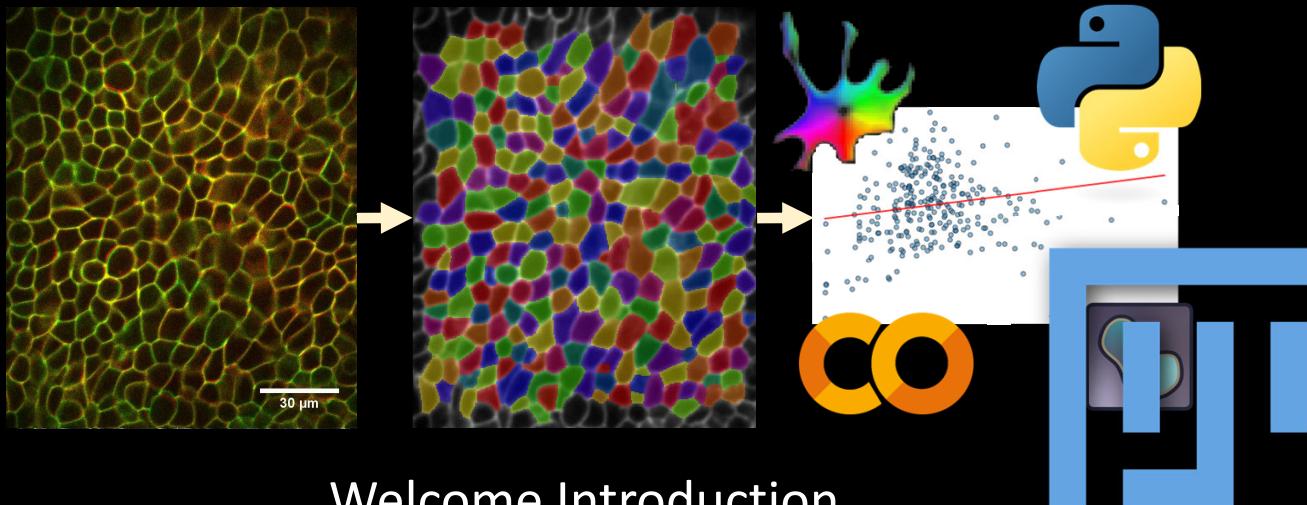
1. Install Anaconda
2. Download the course material

Wifi AP Name:
COVR-1860
Password: abcd1234



Bioimage Analysis Workshop

@ ICOB&IBC, Sinica



Welcome Introduction

2023.1.11

The origin



Cheng-Yu Huang shared a link.
· 21 November at 14:30 · ⓘ

生物影像處理工作坊-需求調查

我正考慮今年底在台北舉辦一天針對大學生到博士生的生物影像處理工作坊。

我知道目前已經有很多網路上或實體的生物影像處理教學和論壇，但在我看來，對於大多數具有生物背景的人來說，自己做影像處理仍然存在著一些障礙。所以這份問卷是為了找出問題所在，以及我想盡我的能力來幫助改善現況。

謝謝你願意花5-7分鐘填寫這份調查！

問卷最後會有工作坊的參與意願，如有興趣請再務必填寫你的電子信箱！

[See more](#)

生物影像處理工作坊 需求調查

我正計畫今年底在台北舉辦一場整天的生物影像處理工作坊。
影像技術在生命科學研究扮演越來越重要的角色。除了常見的光學影像外，優光顯微術、平面或三維立體的成像，活體攝影等，都加大了現今影像的資料量。因此生物影像漸漸需要倚靠軟體的分析處理來得到比人眼判讀更精準的資訊。

我知道目前已經有很多網路上或實體的生物影像處理教學和論壇，但在我看來，對於大多數具有生物背景的人來說，自己做影像處理仍然存在著一些障礙。
所以這份問卷是為了找出問題所在，以及我想盡我的能力來幫助改善現況。

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問卷最後會有工作坊的參與意願，如有興趣請再務必填寫你的電子信箱。

承宇 2022年11月 [tieu12301230@gmail.com]

* Required

你的名
Your name

DOCS.GOOGLE.COM
生物影像處理工作坊
我正考慮今年底前在台北

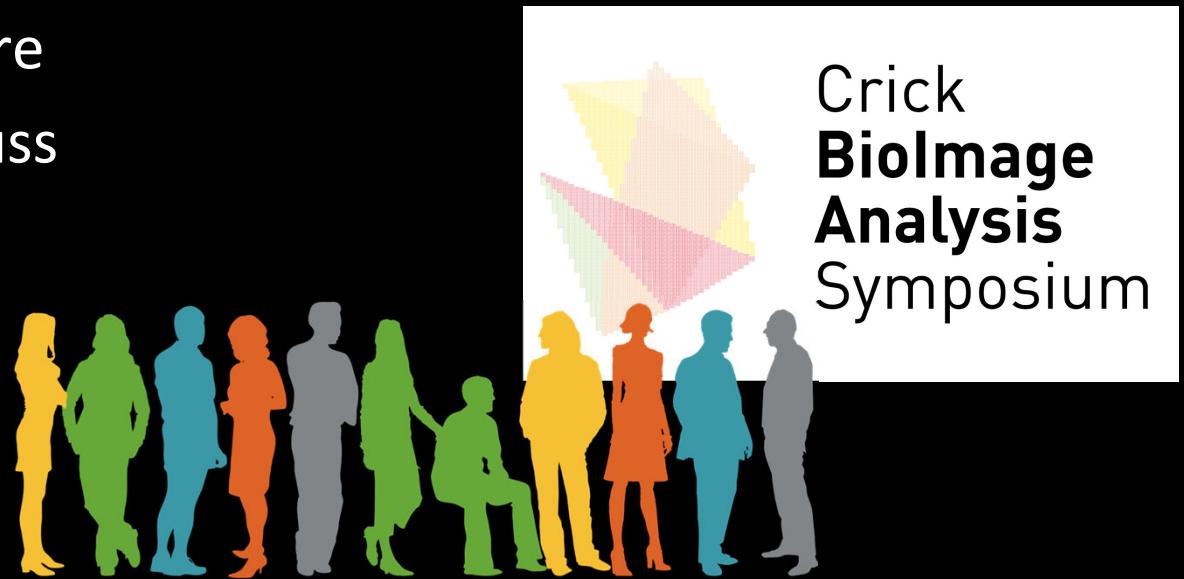
你覺得在台灣的生物影像處理普及上最大的問題是什麼？(資源不足？沒有人可以討論？學生間的合作機會有限？或其實沒有什麼問題？)

Your answer

Image Analysis in Taiwan: Problem

Summary of the questionnaire

1. Can't find people to discuss
2. Limited resources
3. No time

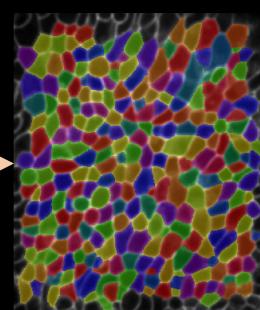
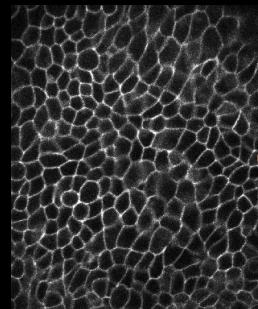


"Image analyst has the responsibility to mentor biologists to on image analysis – and biologists are also responsible to approach to them."

The structure of the course

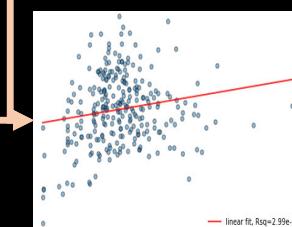
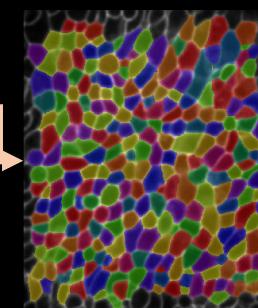
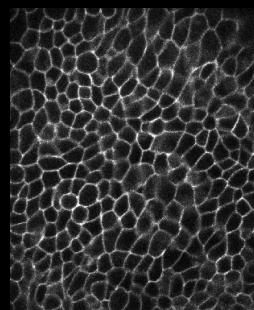
Section 1

Introduction to
Image Operators



Section 2

Machine Learning
Basics & Tools



Section 0



Bioimage
Terminologies

Section 3

How to Think
as a Bioimage
Analyst



Social



Acknowledgement

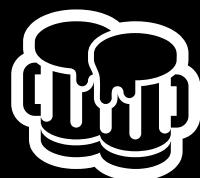


My Teaching Materials are mostly based on the following resources:

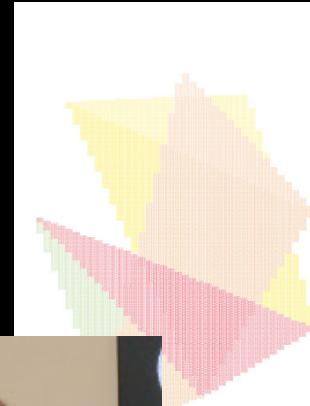
- ***Bioimage Book by Peter Bankhead***
- ***Lecture Bioimage Analysis 2020 by Robert Haase***
- ***Bioimage Analysis in Python Jupyter Notebook by Jonas Hartmann & Toby Hodges***
- ***Google Colab Notebook by Marius Pachitariu***

“There are lots of very good online tutorials – but in person tutorial still have something unbeatable.”

Just before we start...



“What would you teach (about image analysis) if you only have a day?”



Robert Haase



**Crick
Biolimage
Analysis
Symposium**

Self intro time! 😊

Thanks for participating today!

Due to the number of ppl we have today, we will do 10 seconds per person

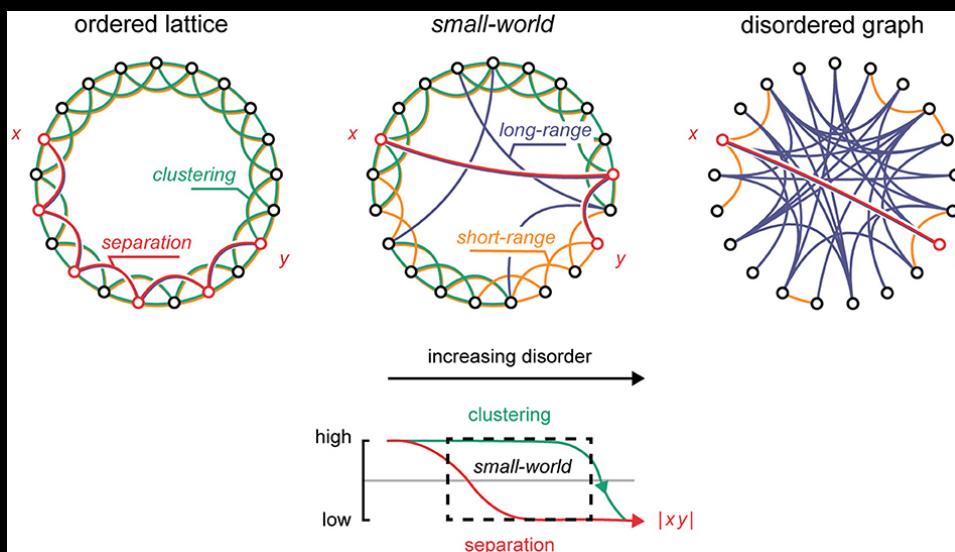
- What's your name?
- What do you do?
- What's your hobby?

Note down who you would like to talk to! 📝

Owner	Last modi...	↓	File size
me	00:22		4.8 MB
me	23:41		9.8 MB
me	23:31		2.6 MB
me	22:58		5 MB
me	21:33		9 MB

Talk to your neighbours!

- To avoid awkwardness, you can ask:
 - What's your name, your sciences, your hobbies
 - What image techniques do you use, and what to quantify
 - How did you spend your new year eve?

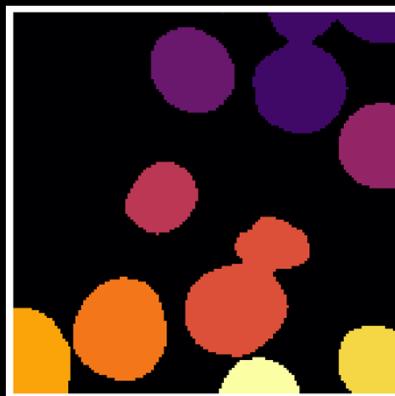


Origin of participants:

生化所
細生所
物理所
生醫所
植微所
化學所
農生中心
生多中心
基因體中心
台大物理所
台大醫學院

Queen's University

Kou (Cheng-Yu Huang)



Introduction to Bio-image Analysis

Most slides and materials were adapted from:

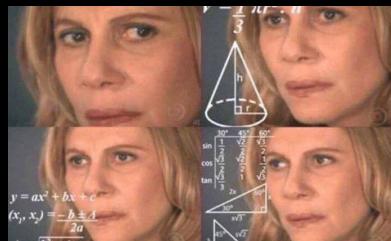
Lecture 1 of Bioimage Analysis 2020 by Robert Haase
Bioimage book by Peter Bankhead

Image analysis is part of the experiment

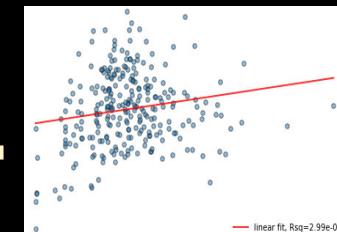


Biological question???

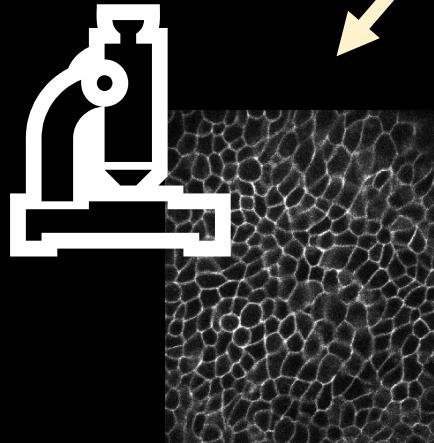
Hypothesis???



Modelling



Bio-statistics



Imaging

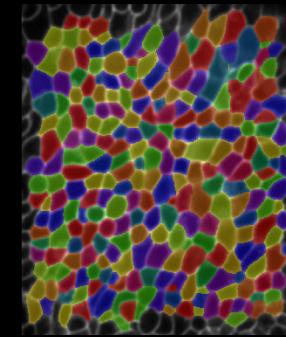


Image processing/ analysis

Bio-image analysis is supposed to be:

- **Quantitative**
 - We derive numbers from images which describe physical properties of the observed sample.
- **Objective**
 - The derived measurement does not depend on who did the measurement. The measurement is free of interpretation.
- **Reliable**
 - We are confident that the measurement is indeed describing what we expect it to describe.
- **Repeatable**
 - We can do the same experiment twice under the same conditions and get the same result.
- **Reproducible**
 - Somebody else can repeat the experiment under different conditions and still gets the same measurements. For this, documentation is decisive!

Why is bio-image analysis so hard?

1. Image highly heterogeneous(異質性)
2. Involve lots of disciplines

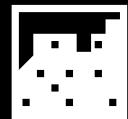
Introducing Terminologies



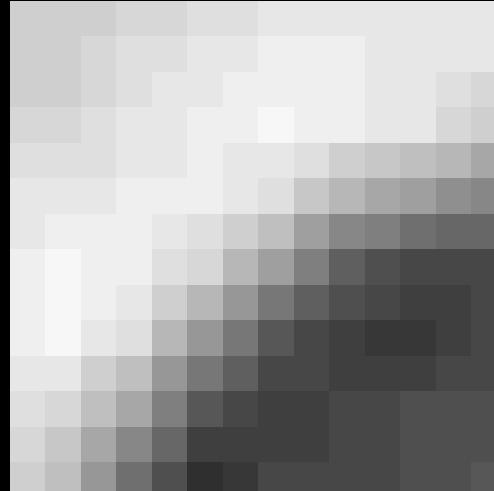
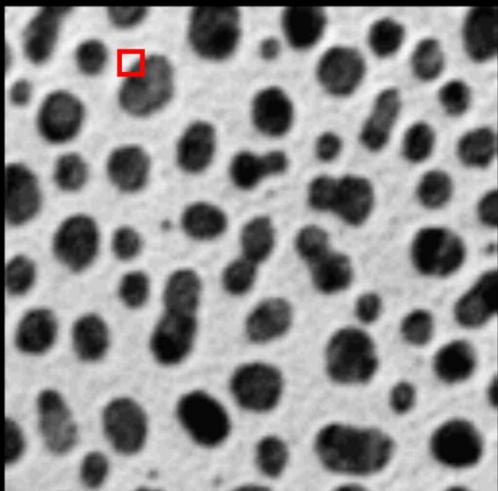
Most slides and materials were adapted from:
Lecture 1 of Bioimage Analysis 2020 by Robert Haase
Bioimage book by Peter Bankhead

* Assume you already know all of them, just that people use different names

Images and pixels



- Images are matrix of numbers
- Pixel = picture + element =
"small, square single-colored display elements that comprise an image," (1969)
 - Edges between pixels DOSENT exist



0

255

48	48	48	40	40	32	32	24	24	24	24	24	24	24	24	24
48	48	40	32	32	24	24	16	16	16	16	24	24	24	24	24
48	48	40	32	24	24	16	16	16	16	16	24	24	32	40	
40	40	32	24	24	16	16	8	16	16	16	24	24	40	48	
32	32	32	24	24	16	24	24	32	48	56	64	72	88		
24	24	24	16	16	16	24	32	56	72	88	96	112	120		
24	16	16	16	24	32	48	64	96	120	128	144	152	152		
16	8	16	16	32	40	72	96	128	160	176	184	184	184		
16	8	16	24	48	72	104	136	160	176	184	192	192	184		
16	8	24	32	72	104	136	168	184	192	200	200	192	184		
24	24	48	64	104	136	160	184	184	192	192	192	184	184	184	
32	40	64	88	128	168	184	192	192	184	184	176	176	176		
40	56	88	120	152	192	192	192	184	184	184	176	176	176		
48	64	104	144	176	208	200	184	184	184	184	176	176	176		

Pixel value & Image formation

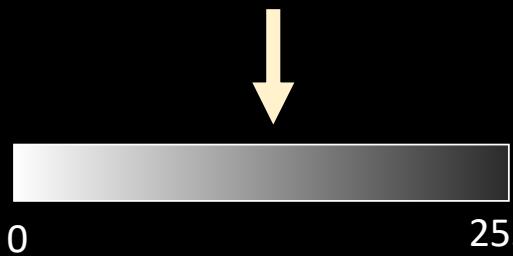
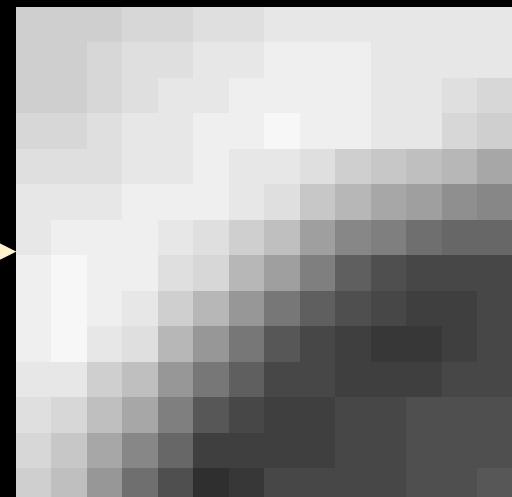
- Pixel values only indirectly related to what's in your sample that we want to measure
 - Exposure time
 - The optical design
 - Sensitivity of the detector
- **Don't over-interpret pixel values!**

O3 image formation video
OWNER, 1/2/2023

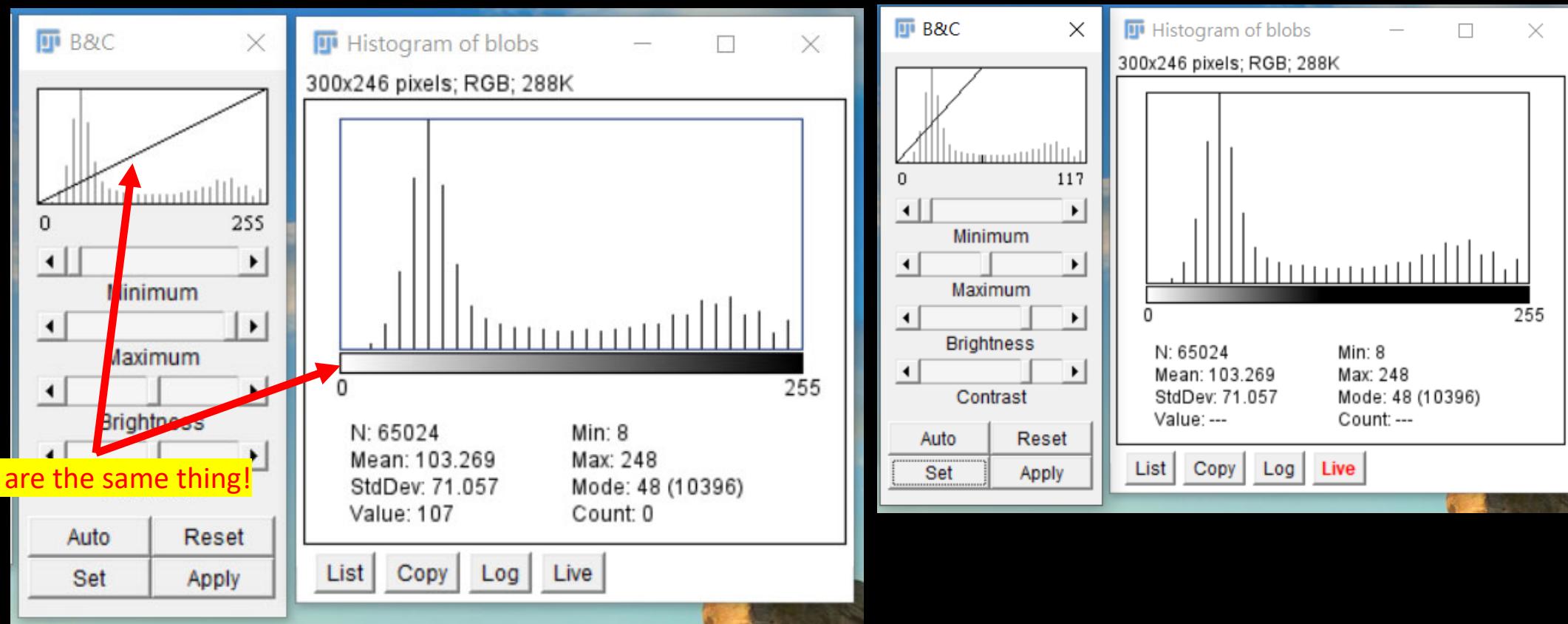
Lookup table (LUT, 對照表)

Lookup Table

48	48	48	40	40	32	32	24	24	24	24	24	24	24	24
48	48	40	32	32	24	24	16	16	16	24	24	24	24	24
48	48	40	32	24	24	16	16	16	16	24	24	32	40	
40	40	32	24	24	16	16	8	16	16	24	24	40	48	
32	32	32	24	24	16	24	24	32	48	56	64	72	88	
24	24	24	16	16	16	24	32	56	72	88	96	112	120	
24	16	16	16	24	32	48	64	96	120	128	144	152	152	
16	8	16	16	32	40	72	96	128	160	176	184	184	184	
16	8	16	24	48	72	104	136	160	176	184	192	192	184	
16	8	24	32	72	104	136	168	184	192	200	200	192	184	
24	24	48	64	104	136	160	184	184	192	192	192	184	184	
32	40	64	88	128	168	184	192	192	184	184	176	176	176	
40	56	88	120	152	192	192	192	192	184	184	176	176	176	
48	64	104	144	176	208	200	184	184	184	184	176	176	168	

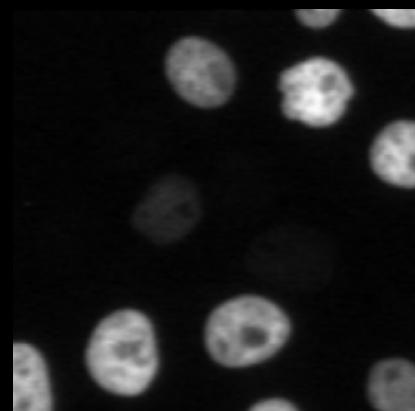


Representation of LUT

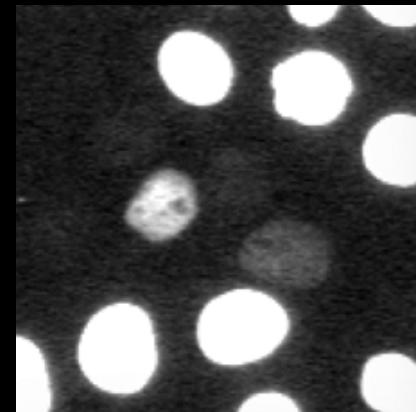
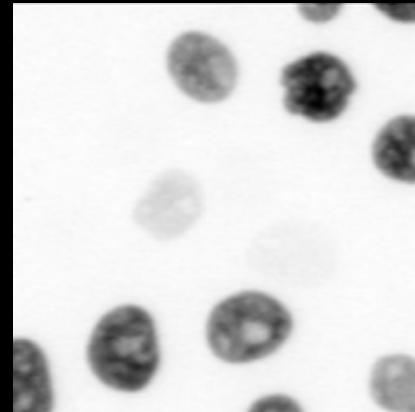
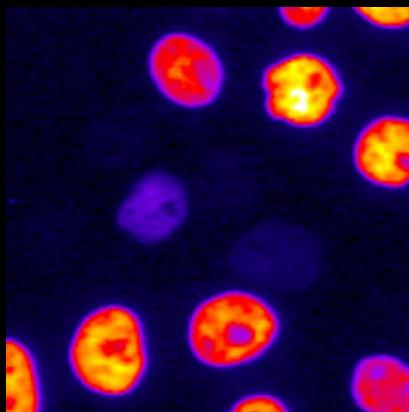


Lookup table (LUT, 對照表)

48	48	48	40	40	32	32	24	24	24	24	24	24
48	48	40	32	32	24	24	16	16	16	16	24	24
48	48	40	32	24	24	16	16	16	24	24	32	40
40	40	32	24	24	16	8	16	16	24	24	40	48
32	32	32	24	24	16	24	24	32	48	56	64	72
24	24	16	16	16	24	32	46	52	78	96	112	120
16	16	16	16	16	24	32	48	64	96	120	128	144
8	16	16	16	32	32	40	72	96	128	156	184	184
8	16	24	48	72	104	136	160	176	184	192	192	192
8	16	24	32	72	104	136	168	184	192	200	200	192
24	24	64	104	136	160	184	184	192	192	192	192	184
32	40	64	88	128	156	184	184	192	192	194	184	176
40	56	88	120	152	192	192	192	192	184	184	176	176
64	64	104	144	176	208	208	184	184	184	184	184	176

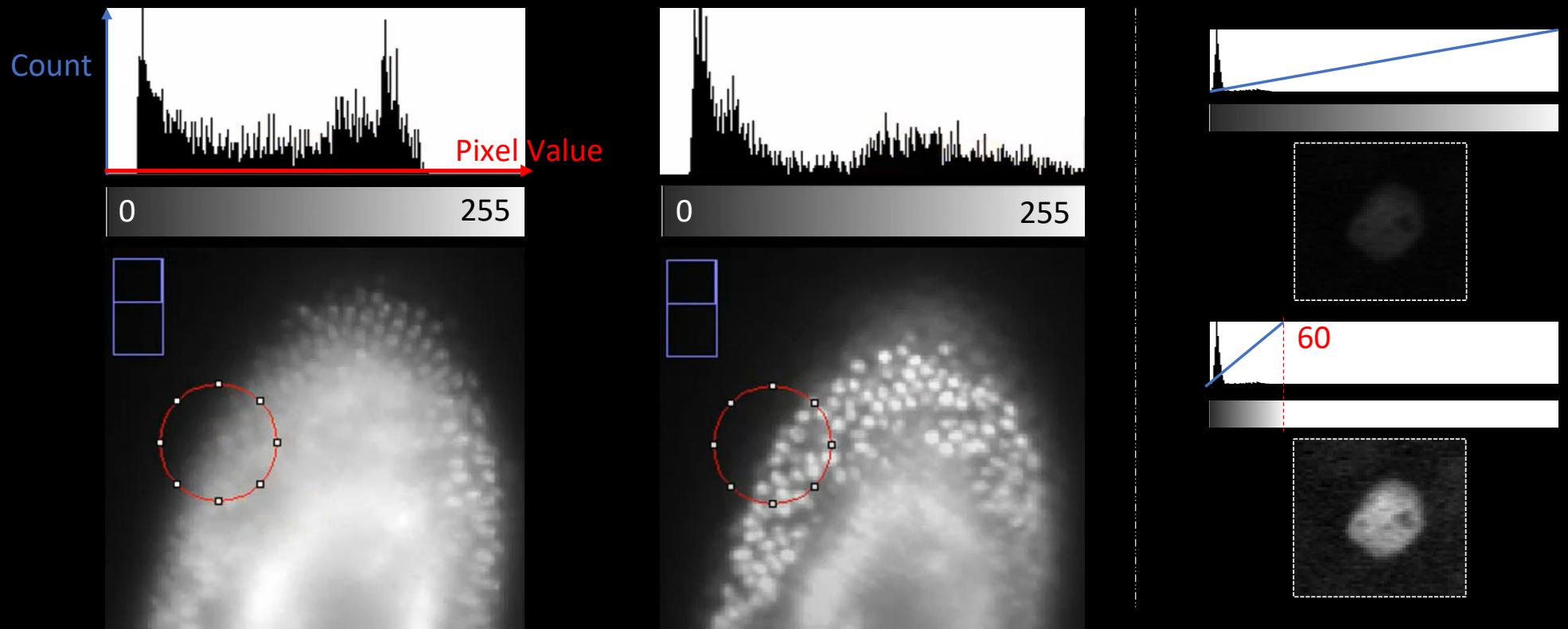


So don't just trust your eyes!

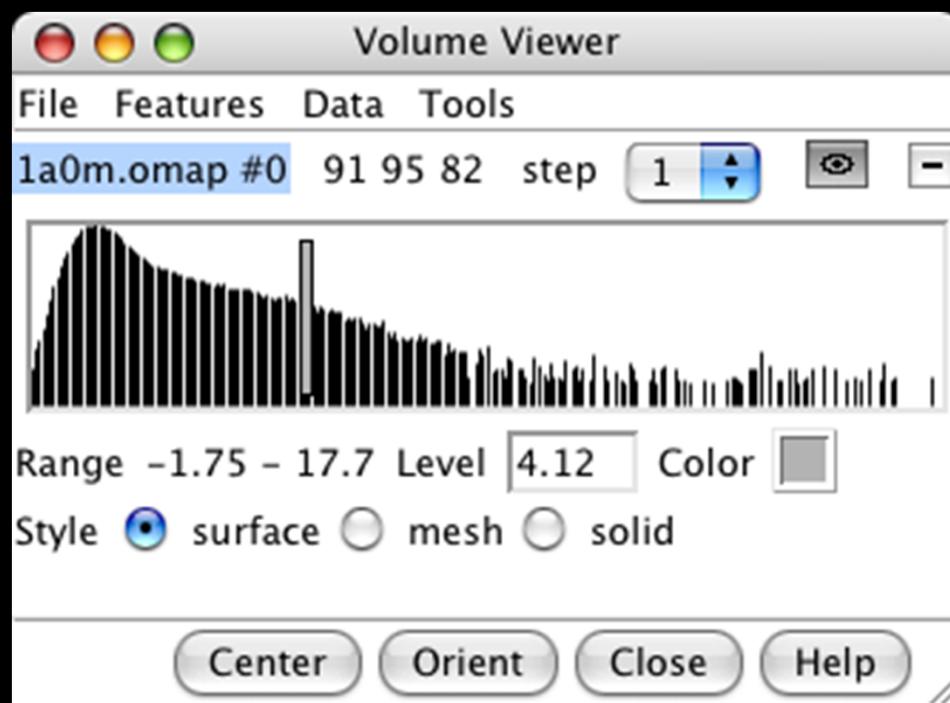


Histogram

- Summary of the image: probability distribution of intensities

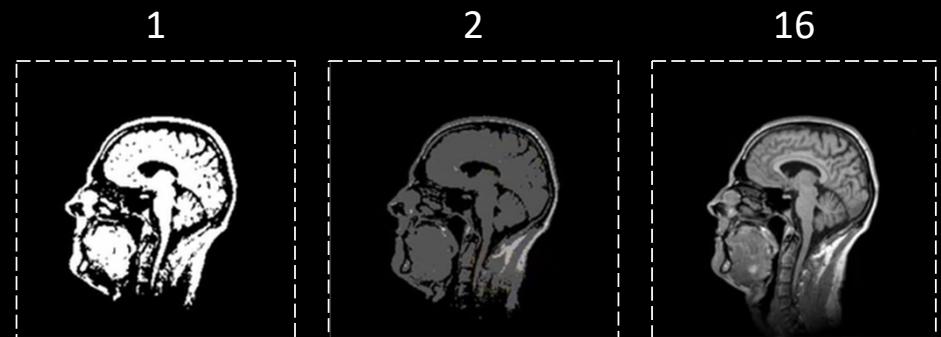
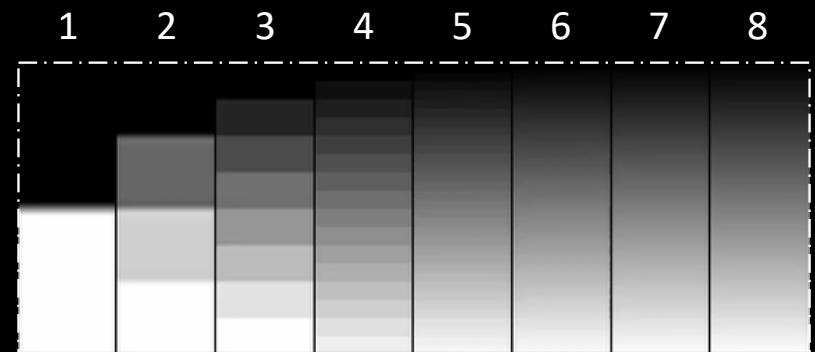


Histogram for protein visualization

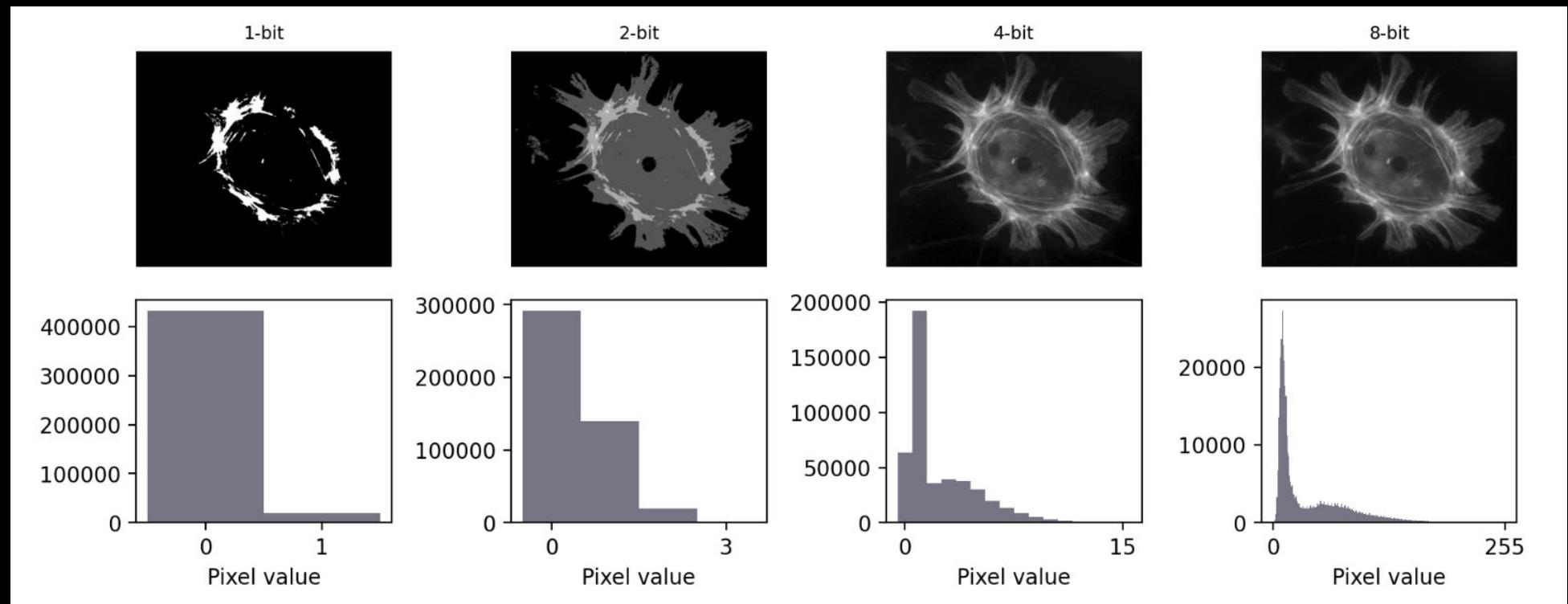


Bit-width (or Bit-depth) 🧠

- In computer, numbers are saved in “bit”
- Bit can either be 1 or 0
- Most images are 8-bit, 12-bit or 16-bit
- For 8-bit images:
 - ➔ $2^8 = 256$ combinations
 - ➔ 0-255 intensity variations
- Less bit-width ➔ less information
 - Irreversible!



Another example...



Bit-width – potential problem

E.g. 8-bit image with intensity level 0-255 (no negative!)

When image subtraction:

- $100 - 200 = 0$
- $100 - 200 = 155$

Or addition:

- $100 + 200 = 255$
- $100 + 200 = 45$

* And problems with rounding

Solution: Change data types during calculations!

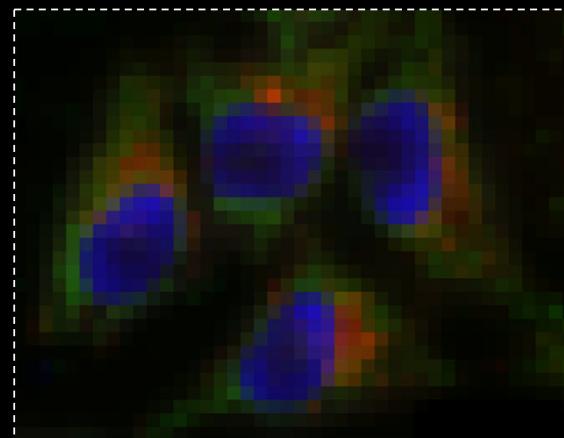
Pixel size v.s. Resolution



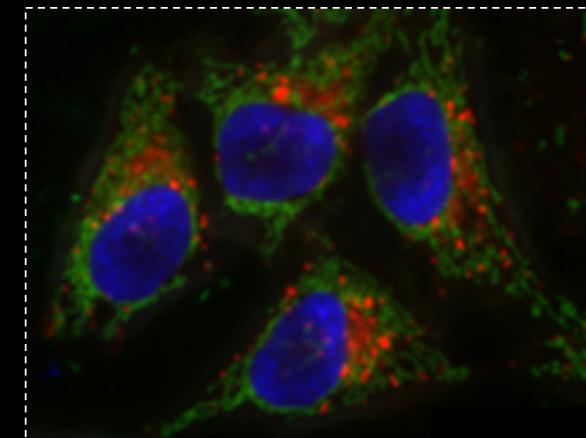
- Pixel size: How the data is saved
- Resolution: Property of the optical system



Pixel size: 3.3 μm



Pixel size: 0.8 μm

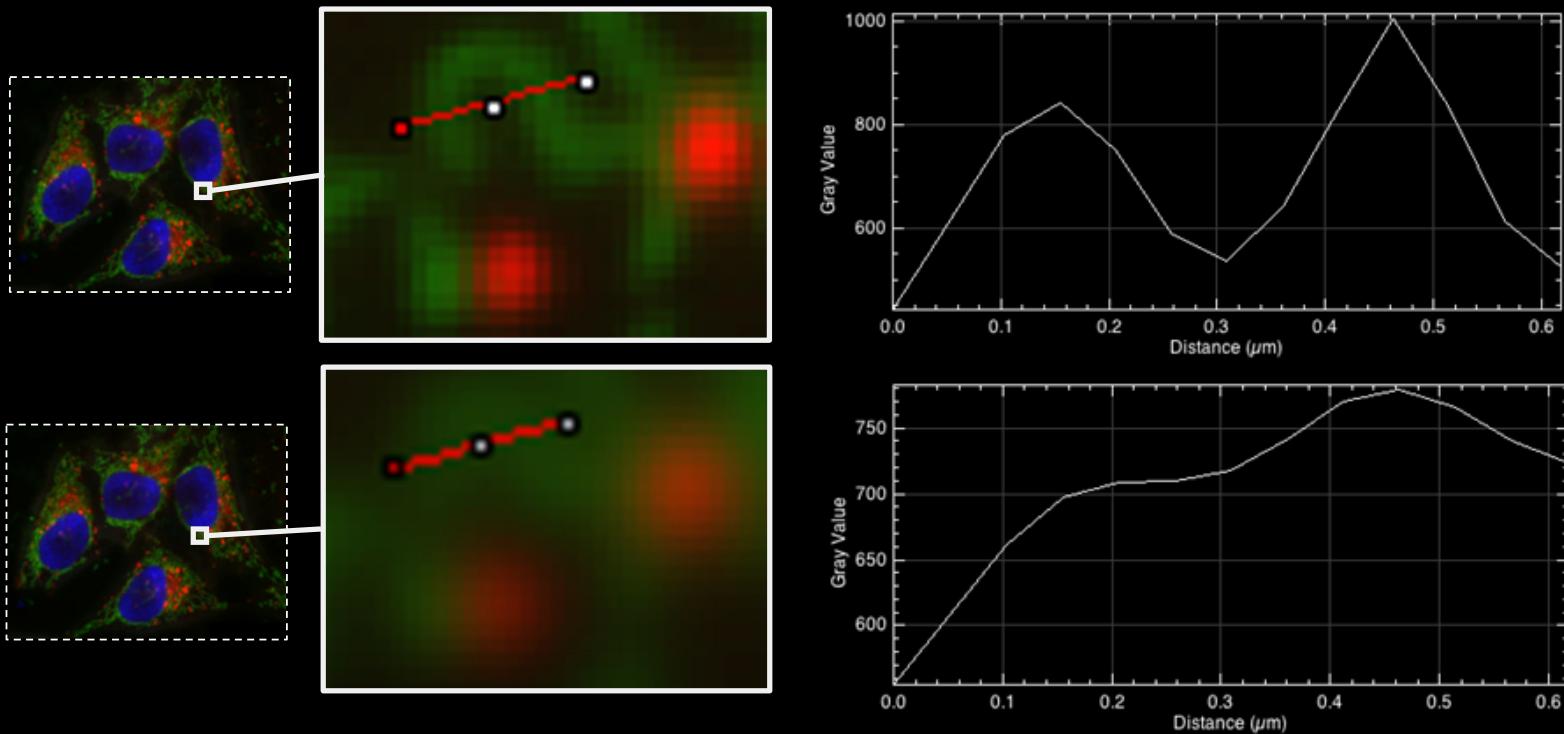


Pixel size: 0.05 μm

Pixel size v.s. Resolution



- Pixel size: How the data is saved
- Resolution: Property of the optical system



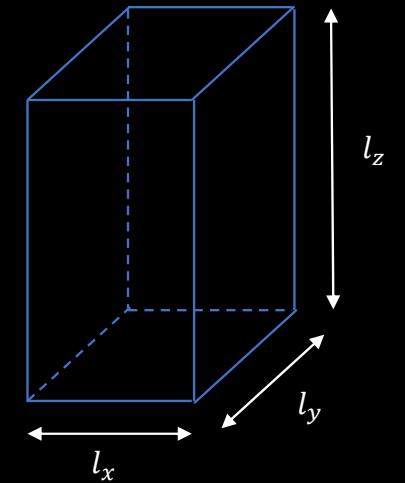
Voxel



- 3D pixel; volume element
- Usually anisotropic: Not the same in all directions

$$l_x = l_y \neq l_z$$

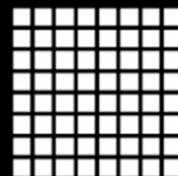
- Image analysts *love* to have isotropic voxels, but it's often not possible.



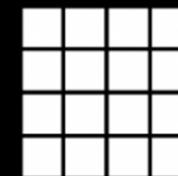
Binning (Down-sampling)



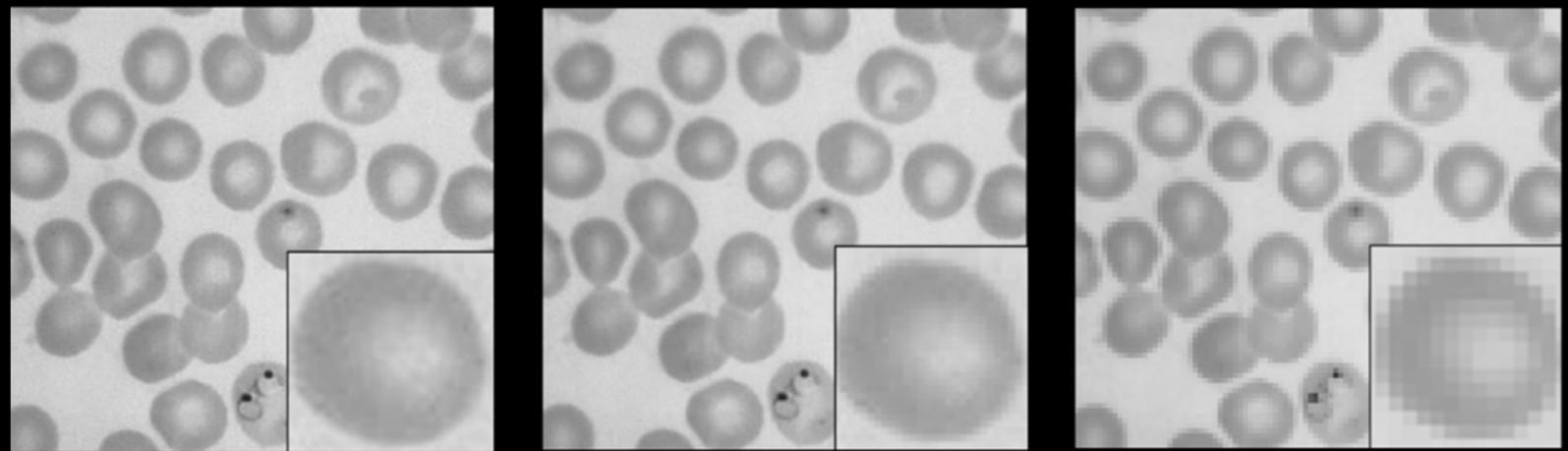
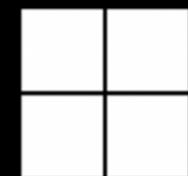
Original



2x2 binning



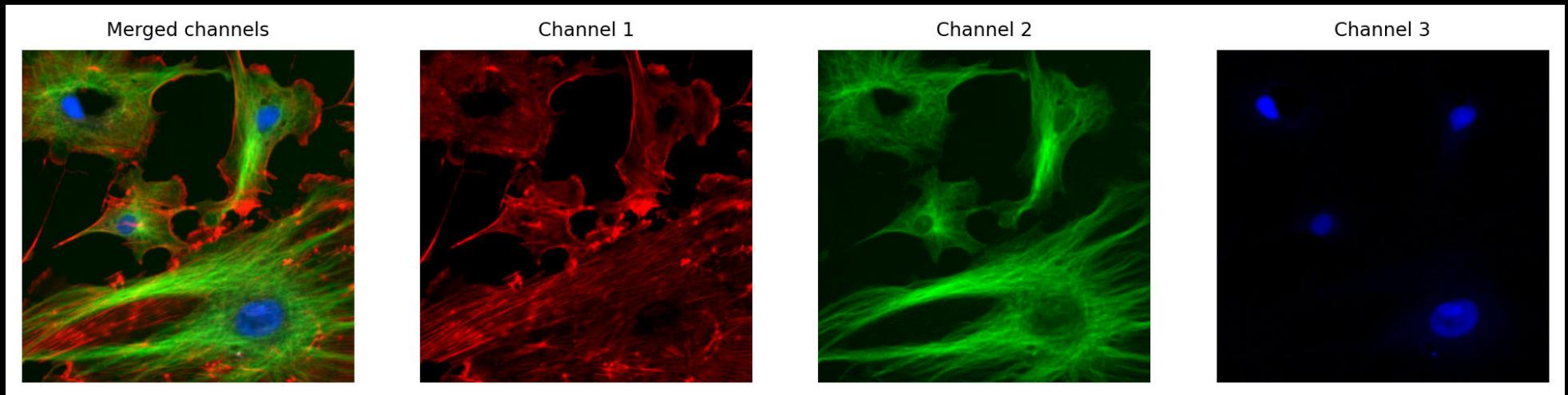
4x4 binning



- Pixels merged to reduce the size of an image
- save the computational resources but might reduce the information content

O2

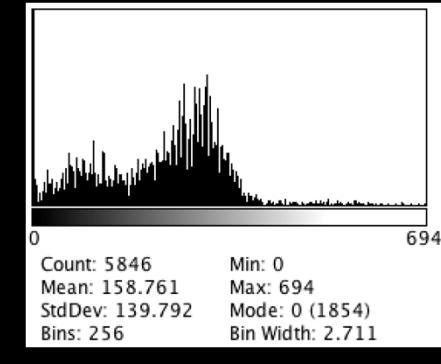
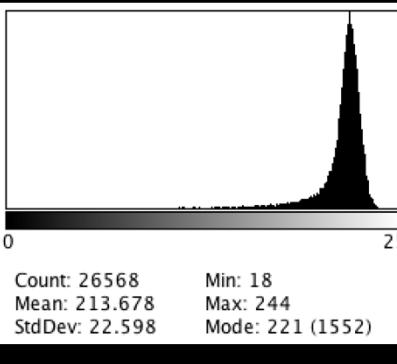
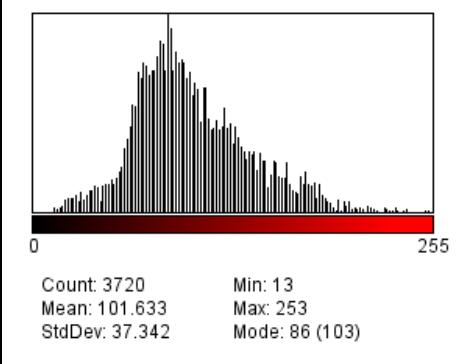
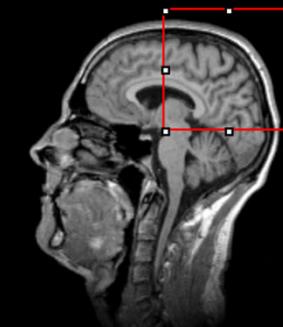
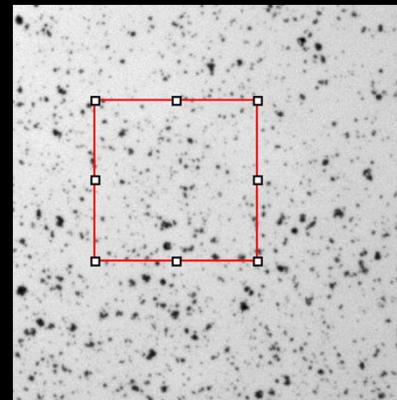
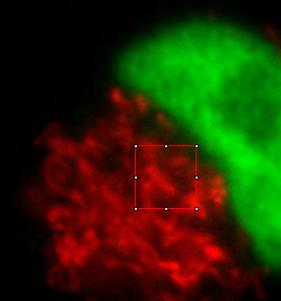
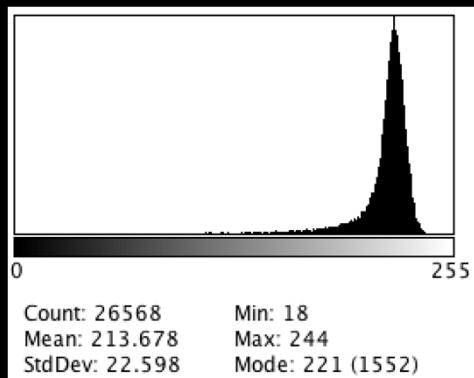
Channels



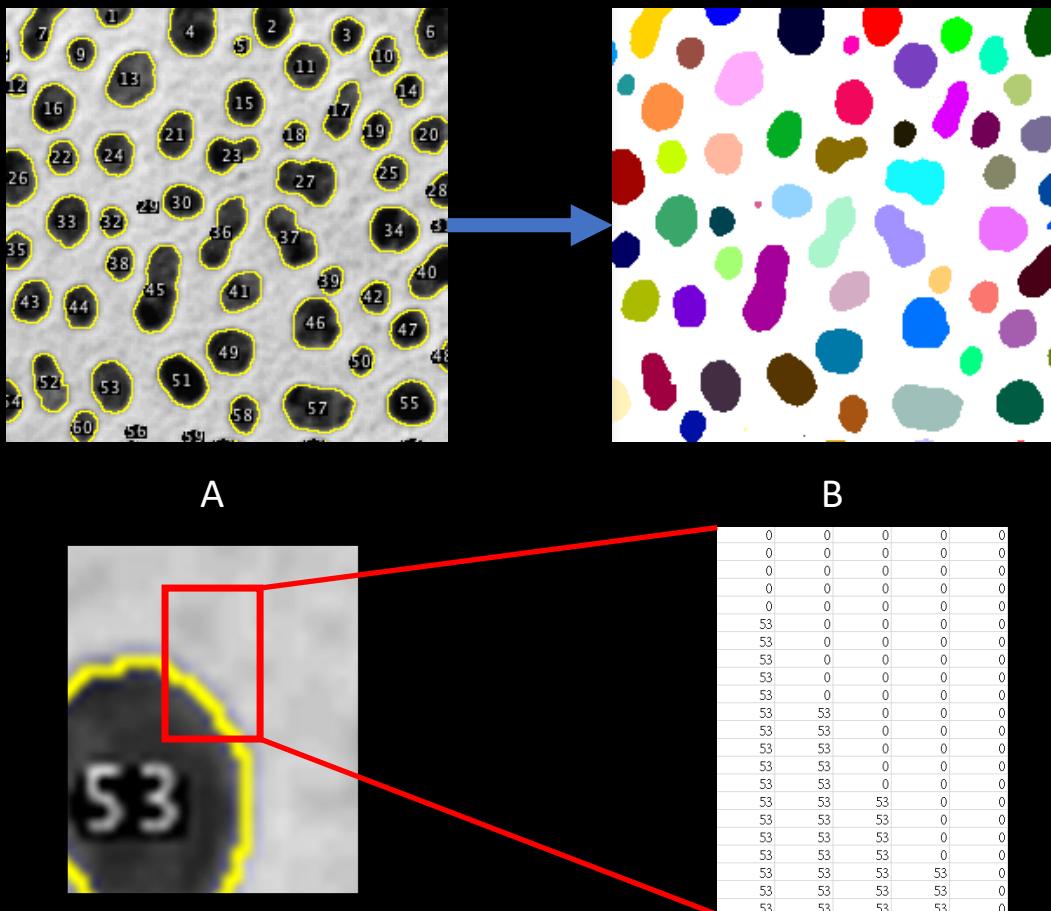
O2 Explain more about channel
OWNER, 1/2/2023

Challenge

- To which of the three selections / images does this histogram belong to?



Challenge



Q: I want to convert image A to image B. There are 60 cells in image A. What is the minimum bit-width that image B should have such that all cells are labelled with different IDs? What would the LUT for image B possibly look like?

Coming Next:

Introduction to Image Operators

DEMO: Setting up your python environment

