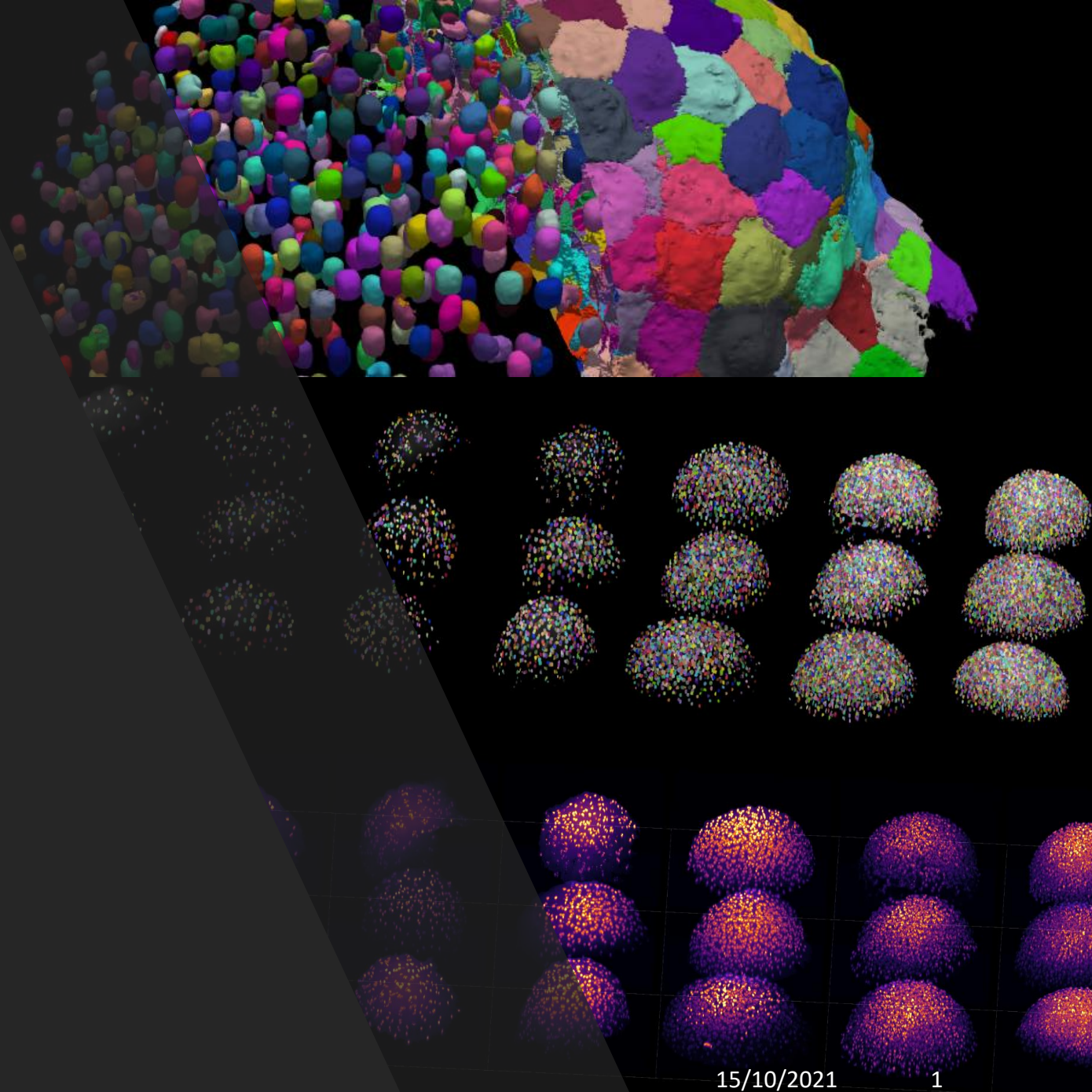


Systems dynamics in cell and developmental biology

IT introduction



Installation of basic components for BIO325

https://bit.ly/bio325_github

Follow the Read Me instructions

Installation of Git

Windows

Downloads



Older releases are available and the [Git source repository](#) is on GitHub.



macOS

Installation of Git for macOS

1. Open the terminal and type the following:


```
git --version
```

2. If Git is not installed yet, follow the instructions to install Xcode Command Line Tools that contain Git.

Installation of Miniconda

<https://docs.conda.io/en/latest/miniconda.html>

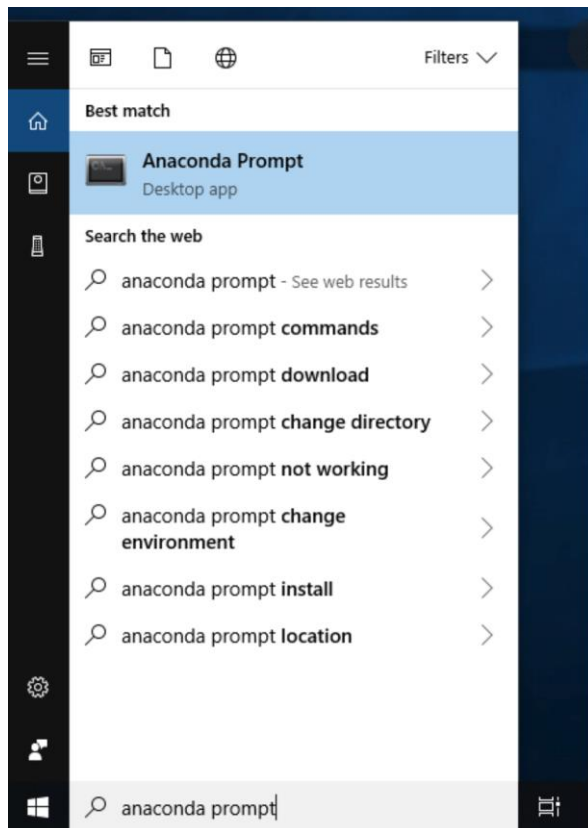
Latest Miniconda Installer Links

Latest - Conda 4.10.3 Python 3.9.5 released July 21, 2021 

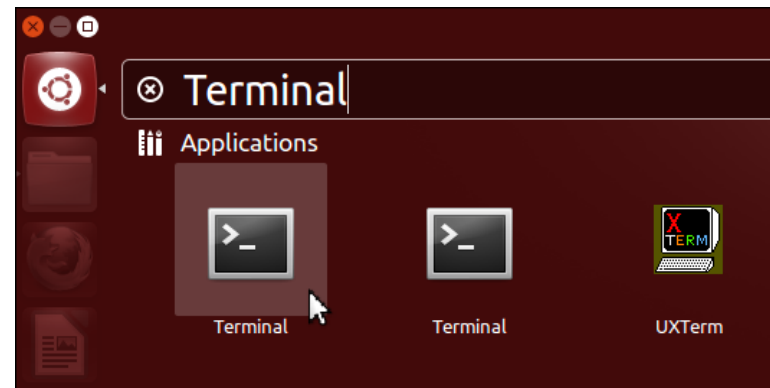
Platform	Name	SHA256 hash
Windows	Miniconda3 Windows 64-bit	<code>b33797064593ab2229a0135dc69001bea05cb56a20c2f243b1231213642e260a</code>
	Miniconda3 Windows 32-bit	<code>24f438e57ff2ef1ce1e93050d4e9d13f5050955f759f448d84a4018d3cd12d6b</code>
MacOSX	Miniconda3 MacOSX 64-bit bash	<code>786de9721f43e2c7d2803144c635f5f6e4823483536dc141ccd82dbb927cd508</code>
	Miniconda3 MacOSX 64-bit pkg	<code>8fa371ae97218c3c005cd5f04b1f40156d1506a9bd1d5c078f89d563fd416816</code>
Linux	Miniconda3 Linux 64-bit	<code>1ea2f885b4dbc3098662845560bc64271eb17085387a70c2ba3f29fff6f8d52f</code>
	Miniconda3 Linux-aarch64 64-bit	<code>4879820a10718743f945d88ef142c3a4b30dfc8e448d1ca08e019586374b773f</code>
	Miniconda3 Linux-ppc64le 64-bit	<code>fa92ee4773611f58ed9333f977d32bbb64769292f605d518732183be1f3321fa</code>
	Miniconda3 Linux-s390x 64-bit	<code>1faed9abecf4a4ddd4e0d8891fc2cdaa3394c51e877af14ad6b9d4aad4e90d8</code>

Create a virtual environment for Python

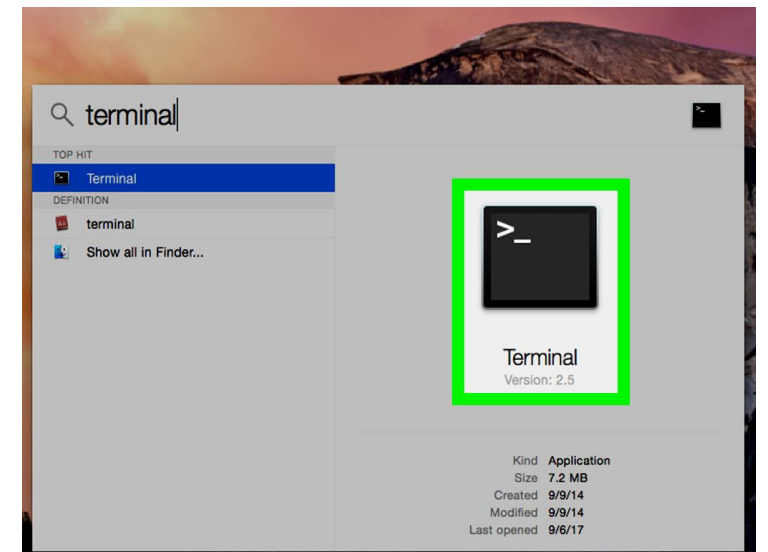
Windows



Linux



macOS



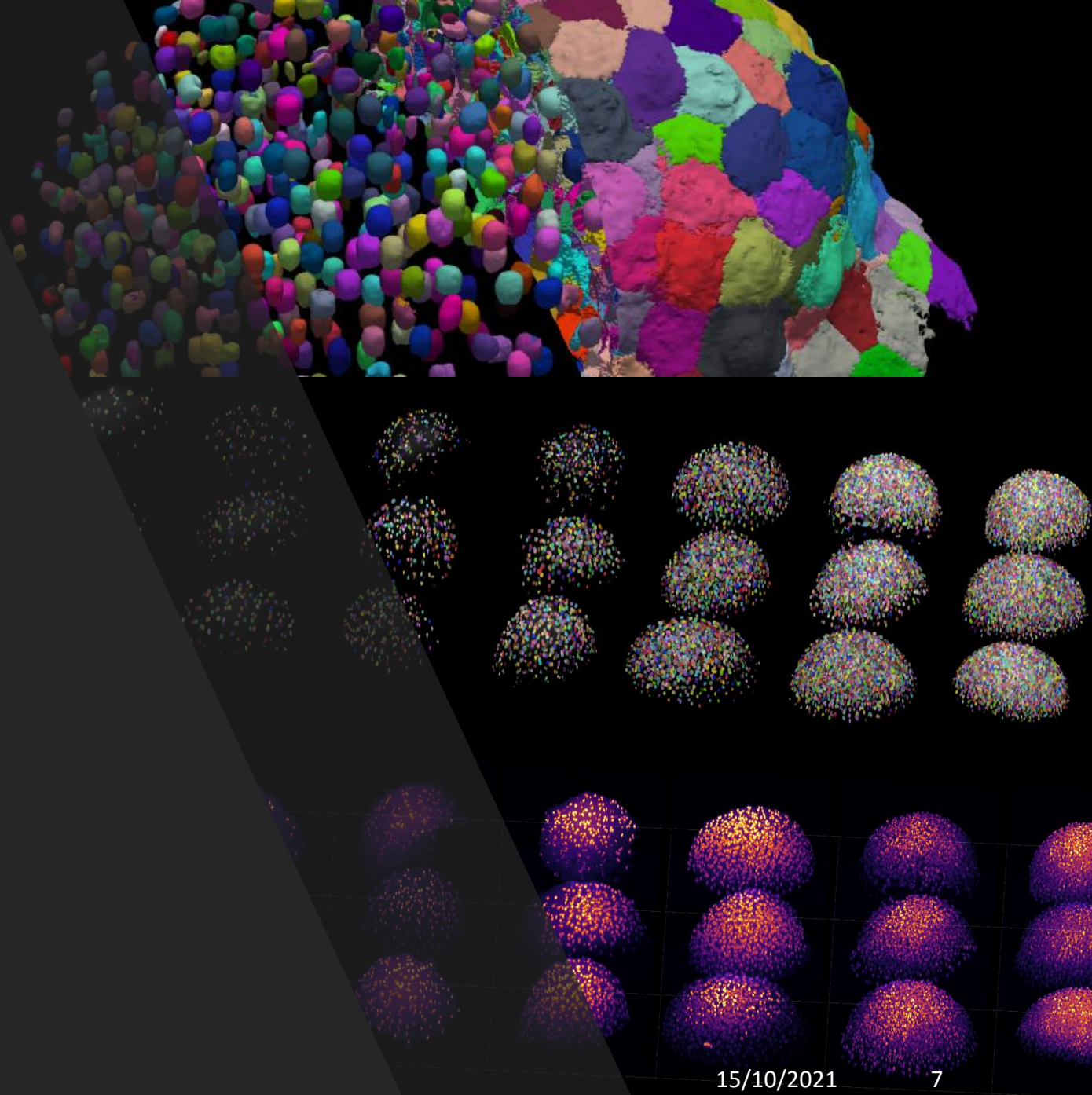
```
conda create -n bio325_2021 python=3.9
conda activate bio325_2021
```

Clone the bio325_2021 github repository and install the requirements

```
git clone https://github.com/jluethi/bio325_2021  
cd bio325_2021  
pip install -r requirements.txt
```

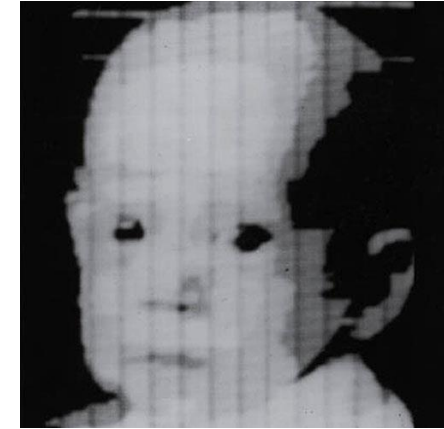

General Introduction

IT introduction

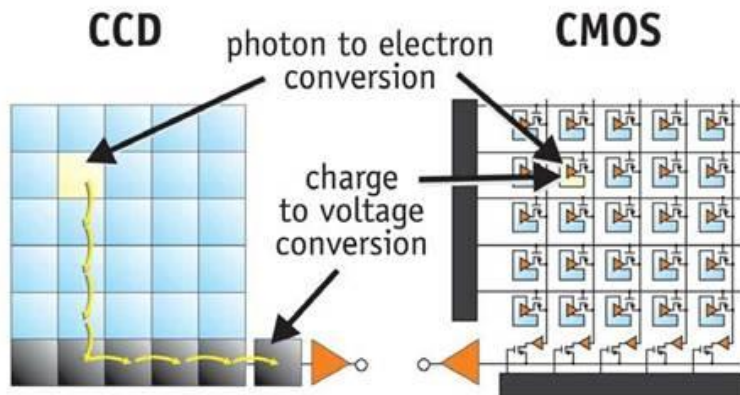


What is a digital image?

- Digital images of real objects are generated by light-sensitive sensors (e.g. CCD or CMOS)
- These sensors are made of small units (pixels) arranged in a grid.
- For each pixel, the incident light is converted into an intensity value.
- The bit-depth of an image defines how many different values a pixel can have
 - E.g. 8-bit image: 256 (2^8) different gray values (0-255)



First digital image (Russel Kirsch, 1957)



Working principle of CCD and CMOS sensors
(https://meroli.web.cern.ch/lecture_cmos_vs_ccd_pixel_sensor.html)



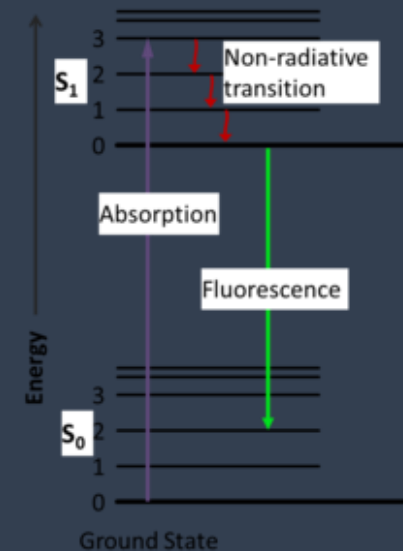
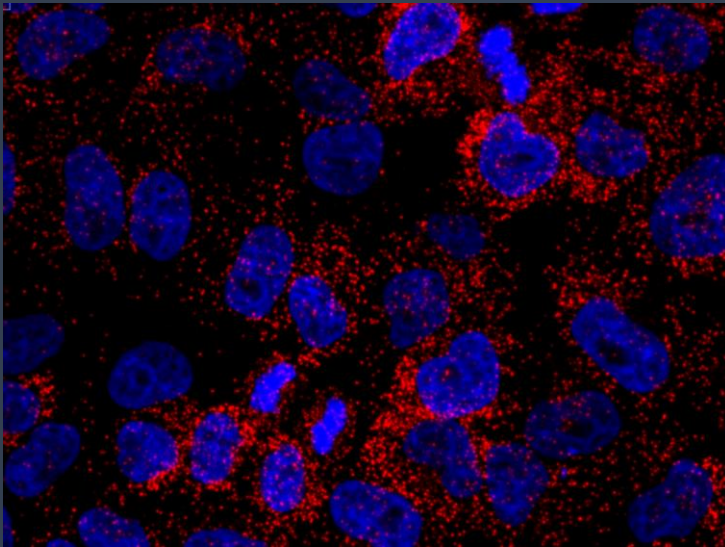
Matrix representation of a grayscale image
(<https://ai.stanford.edu/~syueung/cvweb/tutorial1.html>)

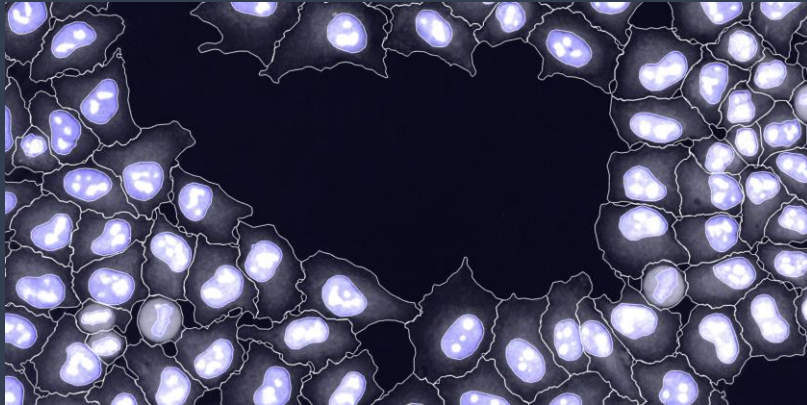
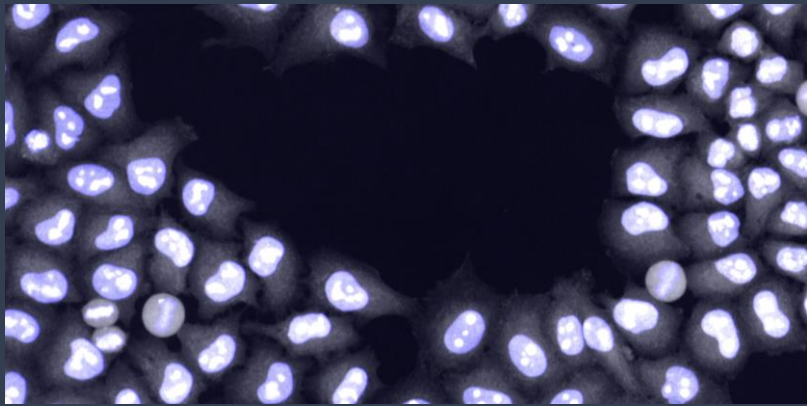
157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	5	10	33	45	105	159	181
206	109	5	124	131	111	120	204	165	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	105	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	85	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	95	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	5	10	33	45	105	159	181
206	109	5	124	131	111	120	204	165	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	105	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	85	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	95	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

Images in fluorescence microscopy

- In fluorescence microscopy, images are generated in the same way just explained
- Fluorescent probes can be excited with a specific wavelength of light and will emit light of a longer wavelength
- The emitted light is then captured by a camera that turns it into a digital image
- We call these types of images «**intensity images**», as opposed to other types of digital images





	A	B	C	D	E	F	G
1	unique_object_id	timepoint	label	area	perimeter	solidity	eccentricity
2	0	0	1	4968	268.651804	0.97699115	0.362955953
3	1	0	2	1747	179.63961	0.9765232	0.890612935
4	2	0	3	4005	246.095454	0.98137711	0.630587232
5	3	0	4	2078	187.053824	0.98065125	0.832344848
6	4	0	5	2166	200.160426	0.97831978	0.865934974
7	5	0	6	4739	261.923882	0.98339905	0.445478743
8	6	0	7	1463	166.325902	0.98187919	0.91467215
9	7	0	8	3918	267.663997	0.93866794	0.876095227
10	8	0	9	6388	309.865007	0.9844352	0.6610052
11	9	0	10	5152	275.4386	0.98659517	0.52864505
12	10	0	11	3495	248.030483	0.9684123	0.586215224
13	11	0	12	4668	266.409163	0.98501794	0.734728655
14	12	0	13	2816	234.124892	0.98255408	0.907836268

Image-based systems biology approach

- The goal is to extract information from images
- Typically, we are interested in measuring features of distinct objects in the image. For example:
 - Cells
 - Nuclei
 - Embryos

The first step in biological image analysis often is to identify where in the image our objects of interests are.

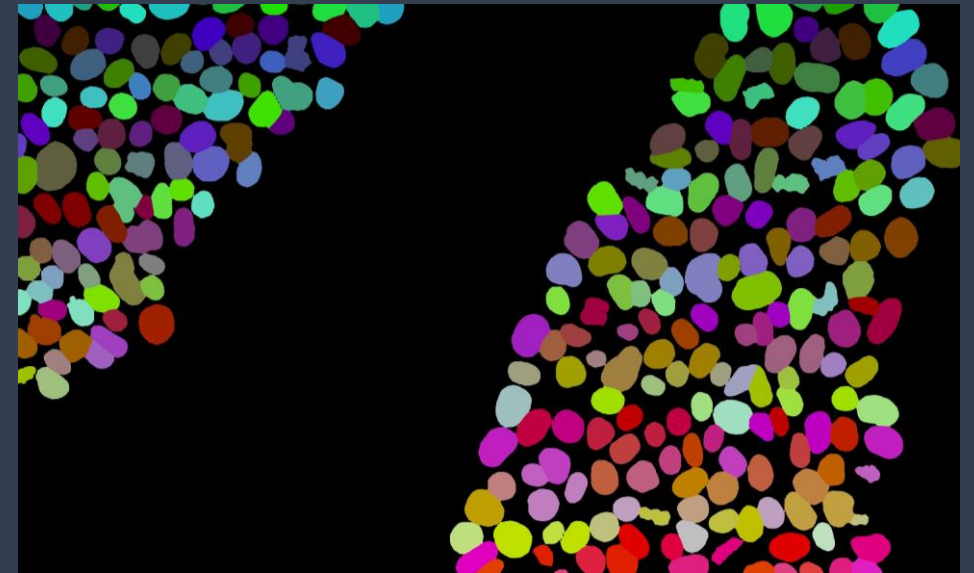
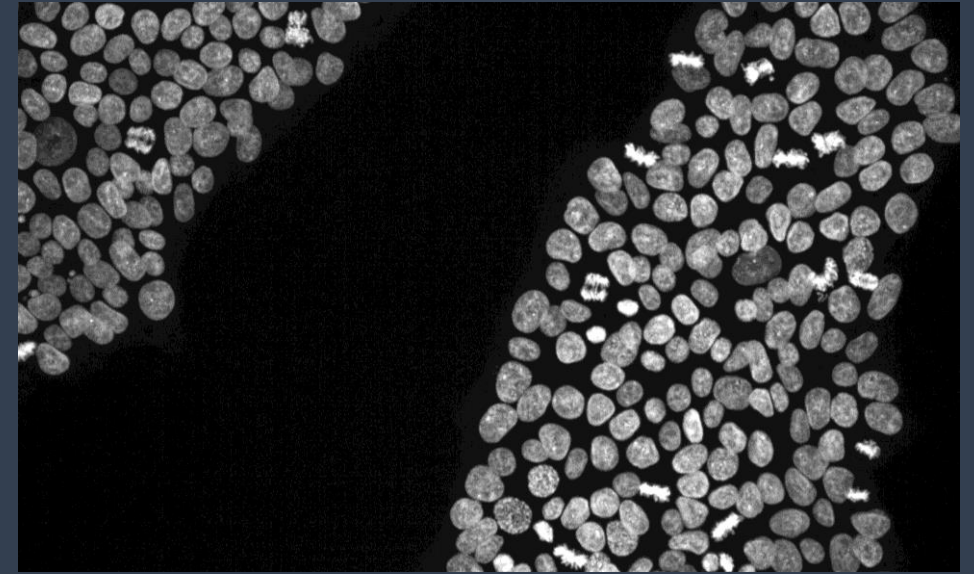
This process is called **image segmentation**

Image segmentation

- The output of image segmentation typically is a «**label image**»
- Background pixels of a label image usually have the value 0
- All pixels assigned to a distinct object have the same value
- Basic measurements can directly be extracted from label images with the help of image-processing libraries

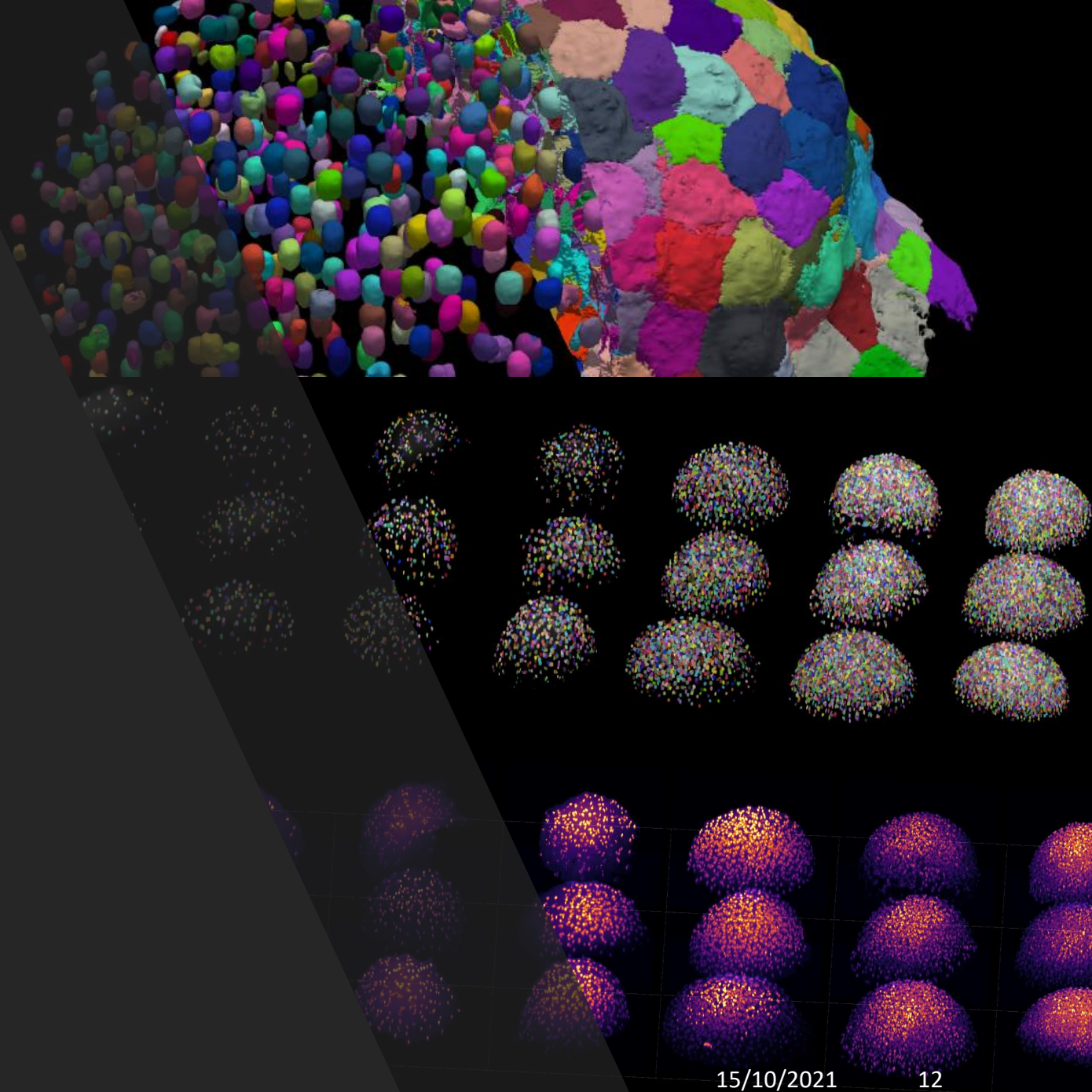


- Typical measurements could be:
 - Area of the object (in pixels)
 - Roundness of the object
 - Mean intensity of all pixels of an intensity image contained in the object

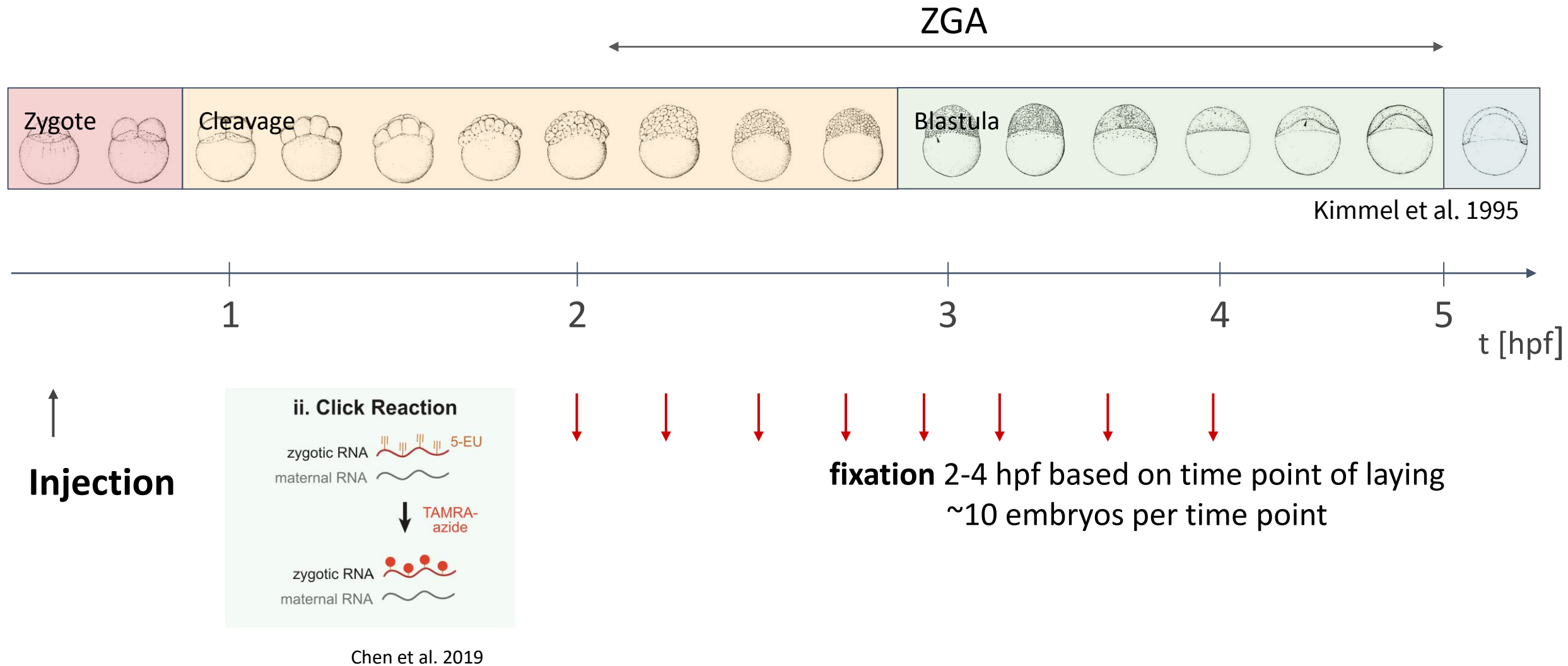


Data exploration and plotting

IT introduction



5-EU injection in zebrafish embryos



Click-it and IF staining

- Pool embryos across timepoints in an Eppi
- Click-it staining with **AF647-azide**
- IF against **β -Catenin (568)** and **PCNA (405)**
- **SYTOX-488** to stain DNA
- 2 replicates