



# DEEPHEALTH

## UC15 - BIMCV COVID19

### Lab 2: pipeline presentation

Winter School 25/01/2022

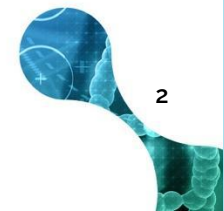


*The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.*



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# Dataset Description



*The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.*



# Dataset Description

Data origin

Data from Medical Imaging Databank in Valencian Region Medical Image Bank (BIMCV)

**2 datasets**

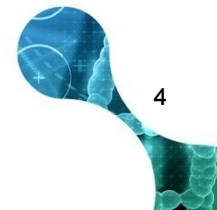


## **BIMCV-COVID19+ (posi)**

Images and medical data from COVID-19 patients

## **BIMCV-COVID19- (neg)**

Images and medical data from **NO** COVID-19 patients





# Dataset Description

## Dataset counts

### Posi dataset

---

- 4.854 subjects
- 13.368 sessions
- 23.527 images

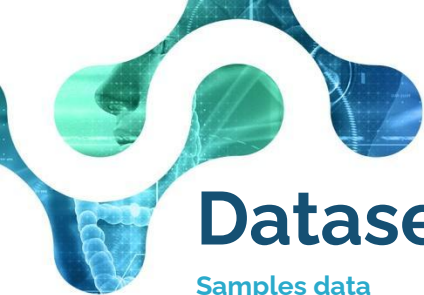
### Neg dataset

---

- 5.201 subjects
- 7.565 sessions
- 18.573 images

### Note

There are 810 common subjects between the posi and neg datasets. They have different subject ID in each dataset.



# Dataset Description

Samples data



**Report:** opacidades de aspecto intersticioalveolar parcheadas y bilaterales que predominan en ambos lobulillos inferiores sospechosas de infeccion por COVID-19 . senos costofrenicos libres .

**Labels:** COVID 19, alveolar pattern, interstitial pattern, pneumonia

**Locations:** costophrenic angle, lobar, bilateral, lower lobe

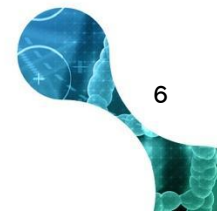
- Image: PNG or NIfTI
- DICOM metadata
- Medical Report
- Labels
- Locations of radiological findings
- COVID tests (only for posi dataset)
- Segmentation (23 images in posi dataset)

## DICOM Fields

Study Date 20200317  
Patient's Sex M  
Patient's Birth Date 1986  
Modality CR  
Manufacturer GE Healthcare  
...

| Date       | Test | Result   |
|------------|------|----------|
| 17.03.2020 | PCR  | NEGATIVE |
| 18.03.2020 | PCR  | NEGATIVE |
| 19.03.2020 | IGG  | POSITIVE |
| 19.03.2020 | IGM  | POSITIVE |
| 20.03.2020 | PCR  | POSITIVE |
| ...        | ...  | ...      |

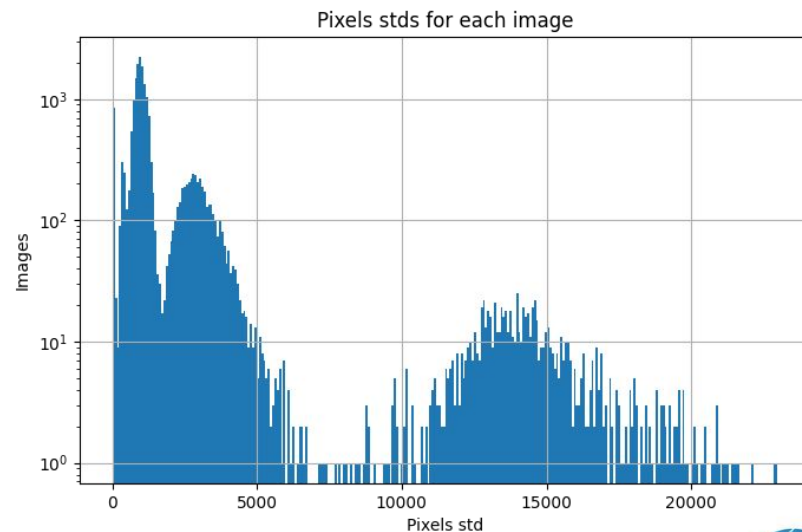
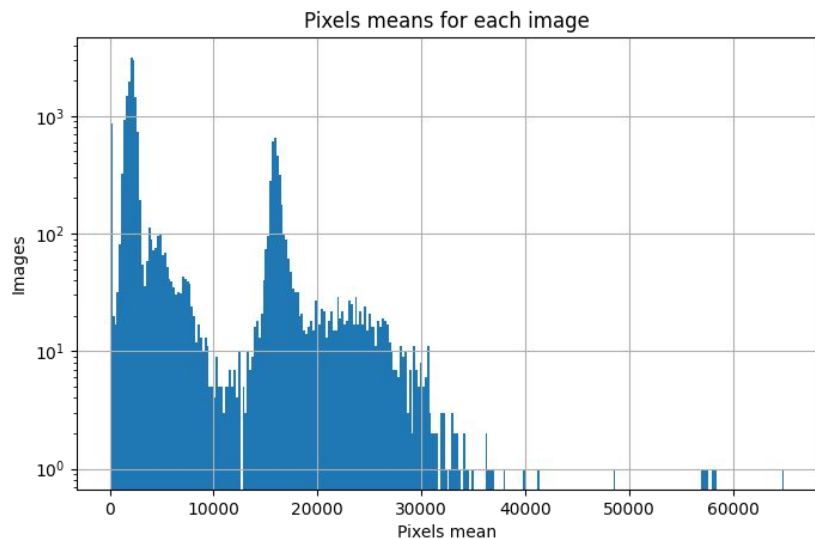
[1] From [BIMCV COVID-19+ preprint](#)





# Dataset Description

Images pixel values distribution





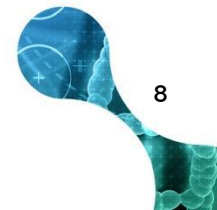
# Dataset Description

## Images shapes

Top 5 most popular shapes

| Shapes      | Number of images |
|-------------|------------------|
| 2336 x 2836 | 1537             |
| 3480 x 4248 | 1241             |
| 3488 x 4256 | 1068             |
| 3480 x 4240 | 955              |
| 2544 x 3056 | 929              |

- 4082 different shapes
  - Most of them with only one image
- High resolution images
  - Between 2k and 3k pixels of height and width







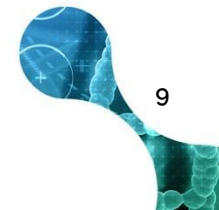
# Dataset Description

## Labels

Most popular labels

| Label             | Count |
|-------------------|-------|
| normal            | 3412  |
| pneumonia         | 3214  |
| increased density | 2996  |
| COVID 19          | 2820  |

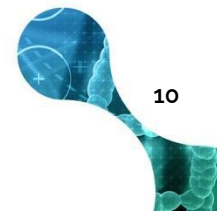
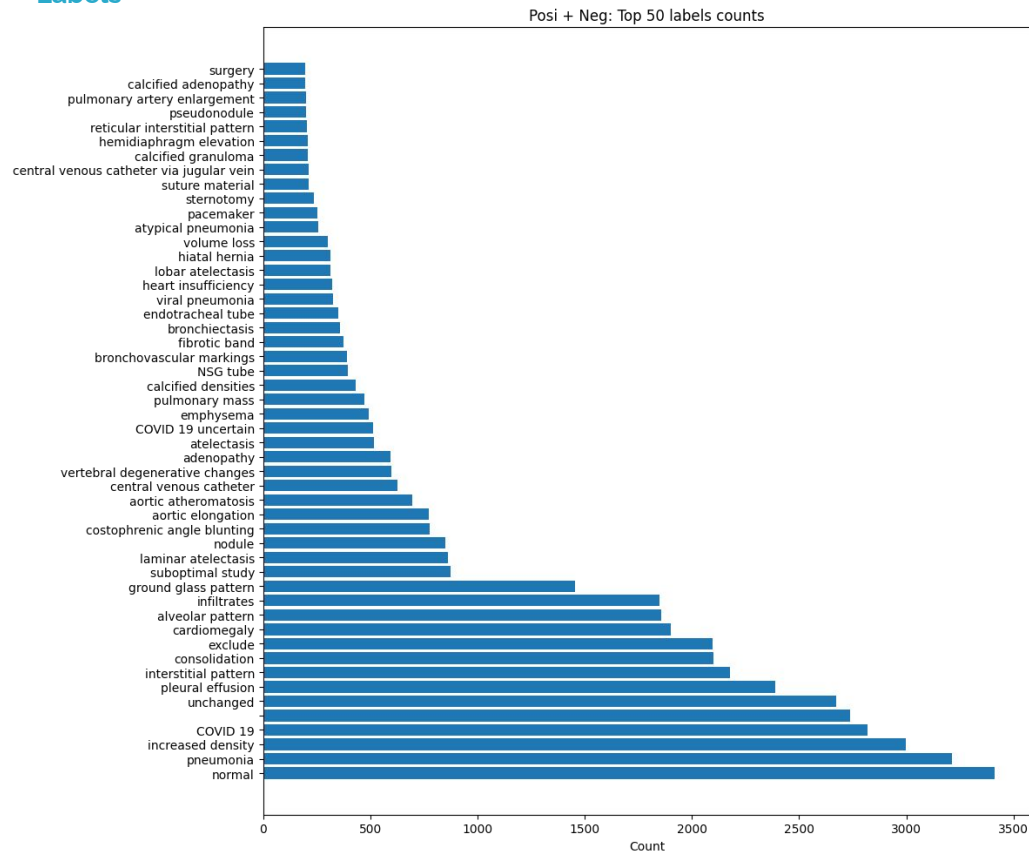
- 190 different labels
- Each sample has a list of labels
- There are samples in the **posi** dataset **without** the "COVID 19" label
- There are samples in the **neg** dataset **with** the "COVID 19" label





# Dataset Description

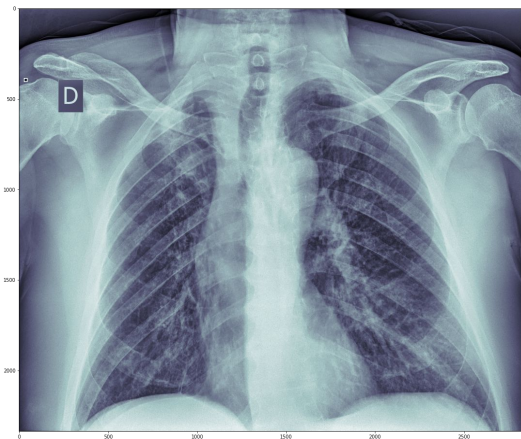
## Labels





# Dataset Description

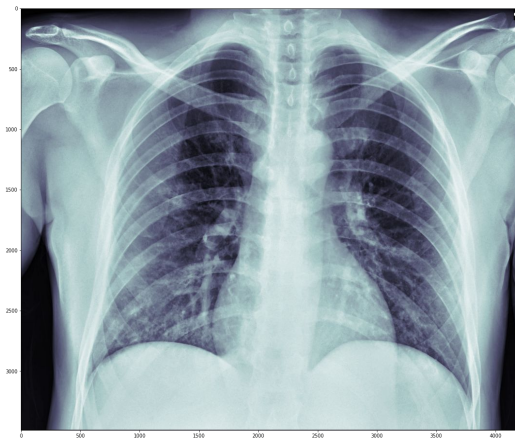
Labels examples



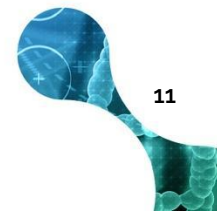
**Pneumonia**

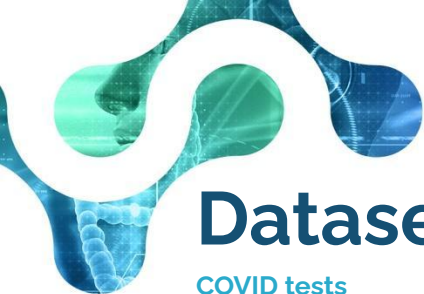


**Infiltrates**



**COVID 19**





# Dataset Description

COVID tests

Tests types

| Test | Count |
|------|-------|
| PCR  | 16442 |
| IGG  | 4273  |
| ACT  | 3294  |
| IGM  | 2724  |

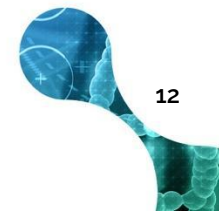
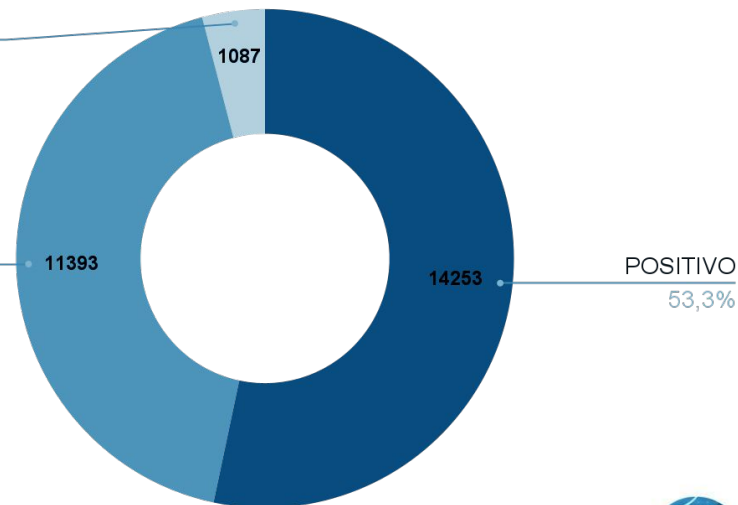
Tests results

INDETERMINADO

4,1%

NEGATIVO

42,6%



# Data Preprocessing



*The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.*



# Data Preprocessing

## Data selection steps

01

### **Relabel using COVID tests (not used)**

Relabel the samples that don't have the "COVID 19" label and they have a positive COVID test

02

### **Filter by classification labels**

Select the samples that have at least one of the labels that are going to be used for classification, e.g. "COVID 19" vs "normal"

03

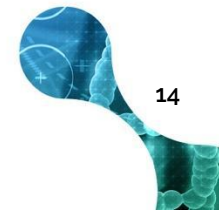
### **Filter by view type**

Select the samples that are Anterior-Posterior (AP) or Posterior-Anterior (PA)

04

### **Filter using manually cleaned data**

We manually labeled the AP and PA samples from the posi dataset to remove the ones that are not correct





# Data Preprocessing

## Image preprocessing steps

01

### **Invert the “MONOCHROME1” images**

The “MONOCHROME1” images have the colors inverted, the background is white and the bones are black

02

### **Images normalization**

Contrast Limited Adaptive Histogram Equalization (CLAHE)

03

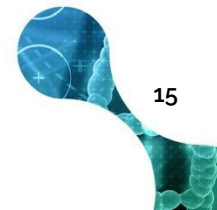
### **Convert to RGB (not used)**

Using the jet colormap and dividing the grayscale in ranges to apply the colors

04

### **Extract lungs ROI**

Using manually labeled masks of the lungs. We trained a U-Net to segment the lungs to perform the ROI extraction

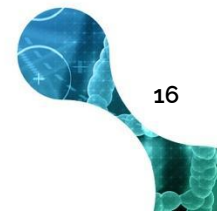




# Data Preprocessing

## Data splits

- The original dataset doesn't have the training splits defined
- We created a 80-10-10 (train-val-test) split
- The splits are defined at patient level: to avoid having samples from one patient in different splits





# Pipeline



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**3 versions**

**Python PyEDDL + PyECVL**

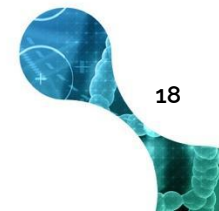
Main version (the one we are going to use here)

**C++ EDDL + ECVL**

For the C++ users (not complete)

**Python Pytorch**

To compare performance of some experiments



# Experiments



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# Experiments

## Configurations of the experiments

### Models

Pretrained VGG and ResNet

### Data shape

256x256 and 512x512

### Optimizers

Adam and SGD

LR: From  $1e^{-4}$  to  $1e^{-7}$

### Regularization

L2 regularization. From  $1e^{-2}$  to  $1e^{-6}$

### Data augmentation

Mirror, Rotation, Brightness and GammaContrast

### Losses

2 classes: CE and BCE

4 classes (multilabel): BCE and MSE



# Experiments

Best results

| Exp. | Task  | Model                | Data shape | Optimizer | Learning rate | Regularization  | DA  |
|------|---|----------------------|------------|-----------|---------------|-----------------|-----|
| 0    | <b>normal</b> vs <b>COVID</b><br>(With BCE loss)  | Pretrained ResNet101 | 256x256    | Adam      | $1e^{-5}$     | L2( $1e^{-5}$ ) | 1.1 |
| 1    | <b>normal</b> vs <b>COVID</b><br>vs <b>pneumonia</b> vs <b>infiltrates</b><br>(With BCE loss) | Pretrained ResNet101 | 512x512    | Adam      | $1e^{-5}$     | L2( $1e^{-5}$ ) | 1.1 |





# Experiments

Experiment 0 results

| Test loss (BCE) | Test accuracy (%) | Test balanced accuracy (%) |
|-----------------|-------------------|----------------------------|
| 0,404           | 88,57             | 83,57                      |





# Experiments

## Experiment 1 results

| Metric    | normal | COVID | pneumonia | infiltrates |
|-----------|--------|-------|-----------|-------------|
| Accuracy  | 0,841  | 0,721 | 0,596     | 0,629       |
| Precision | 0,423  | 0,8   | 0,462     | 0,474       |
| Recall    | 0,379  | 0,316 | 0,3       | 0,493       |
| F1-score  | 0,4    | 0,453 | 0,364     | 0,483       |



# Resources



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# Resources

- [1] Dataset preprint: <https://arxiv.org/abs/2006.01174>
- [2] BIMCV: <https://bimcv.cipf.es/bimcv-projects/bimcv-covid19/>
- [3] Pipeline: [https://github.com/deephealthproject/UC15\\_pipeline](https://github.com/deephealthproject/UC15_pipeline)





DEEPHEALTH

# Thank you!

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allochi@prhlt.upv.es

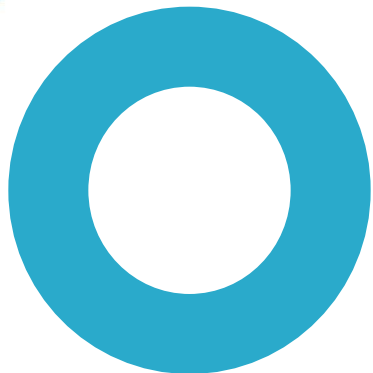


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# 4 main concepts

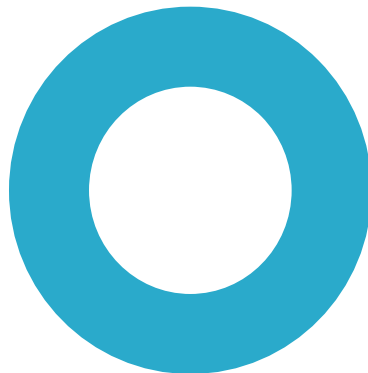
YOU CAN INCLUDE IMAGES IN THE CIRCLES



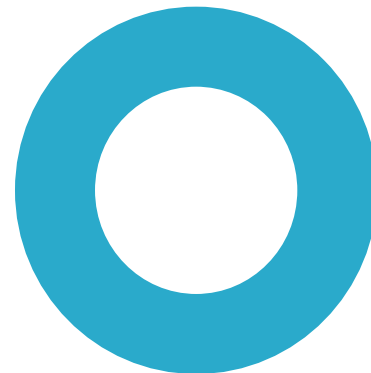
ITEM 1



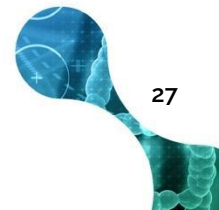
ITEM 2



ITEM 3



ITEM 4



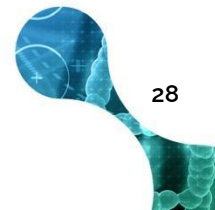


# Our phillosophy

MORE QUALITY LESS QUANTITY



- Lorem ipsum dolor sit amet, consectetur adipiscing elit. Fusce diam tortor
  - Duis quis viverra urna, in ultricies diam.
    - Morbi sodales volutpat tellus, quis aliquam urna cursus et.





# The project

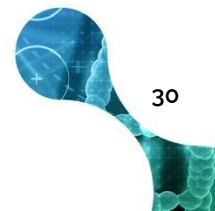


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# List items

List of items



# Concepts



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# Double images

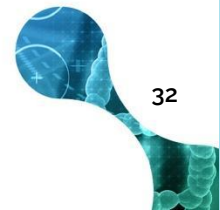
PUT YOUR PORTFOLIO IMAGES HERE

## Gallery image feature 01

**Lorem ipsum dolor sit amet**, consectetur adipiscing elit. Fusce diam tortor, mattis quis dapibus vitae, euismod non purus.aecenas ut.

## Gallery image feature 02

**Lorem ipsum dolor sit amet**, consectetur adipiscing elit. Fusce diam tortor, mattis quis dapibus vitae, euismod non purus.aecenas ut.







- Triple images
- **PUT YOUR  
PORTFOLIO IMAGES  
HERE**



#### **Gallery image feature 01**

Lorem ipsum dolor sit amet,  
consectetur adi piscing elit.  
Fusce diam tortor, mattis.



#### **Gallery image feature 02**

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diam tortor, mattis.



#### **Gallery image feature 03**

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consectetur adi piscing elit. Fusce  
diam tortor, mattis.





# Triple images

PUT YOUR PORTFOLIO IMAGES HERE

## Gallery image feature 01

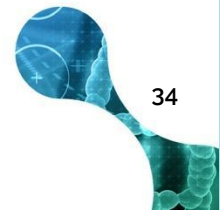
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## Gallery image feature 02

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## Gallery image feature 03

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Fusce diam tortor.





- Image with info
- **PUT YOUR  
PORTFOLIO IMAGES  
HERE**

#### **Gallery image feature 01**

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#### **Gallery image feature 02**

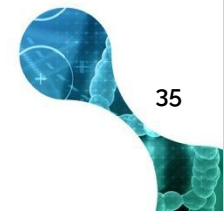
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#### **Gallery image feature 03**

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#### **Gallery image feature 04**

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# Image with info

PUT YOUR PORTFOLIO IMAGES HERE

## Gallery image feature 01

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mattis quis dapibu purus

## Gallery image feature 01

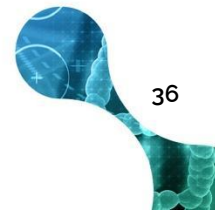
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## Gallery image feature 01

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## Gallery image feature 01

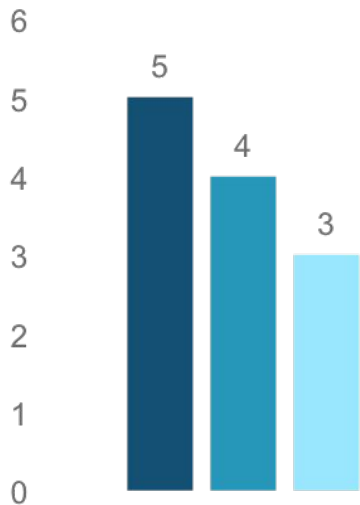
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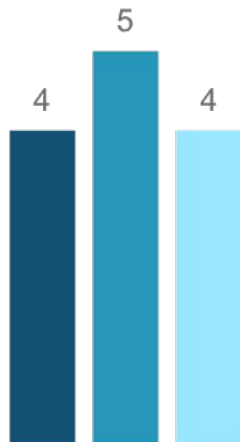
# Bar charts

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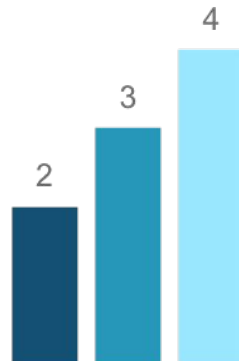
**TITLE EXAMPLE**

Lorem ipsum dolor sit amet,  
consectetur adipiscing elit.



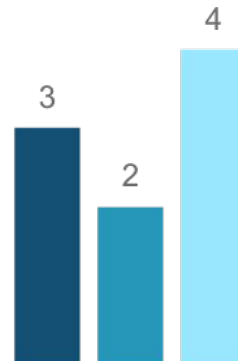
**TITLE EXAMPLE**

Lorem ipsum dolor sit amet,  
consectetur adipiscing elit.



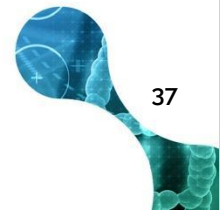
**TITLE EXAMPLE**

Lorem ipsum dolor sit amet,  
consectetur adipiscing elit.



**TITLE EXAMPLE**

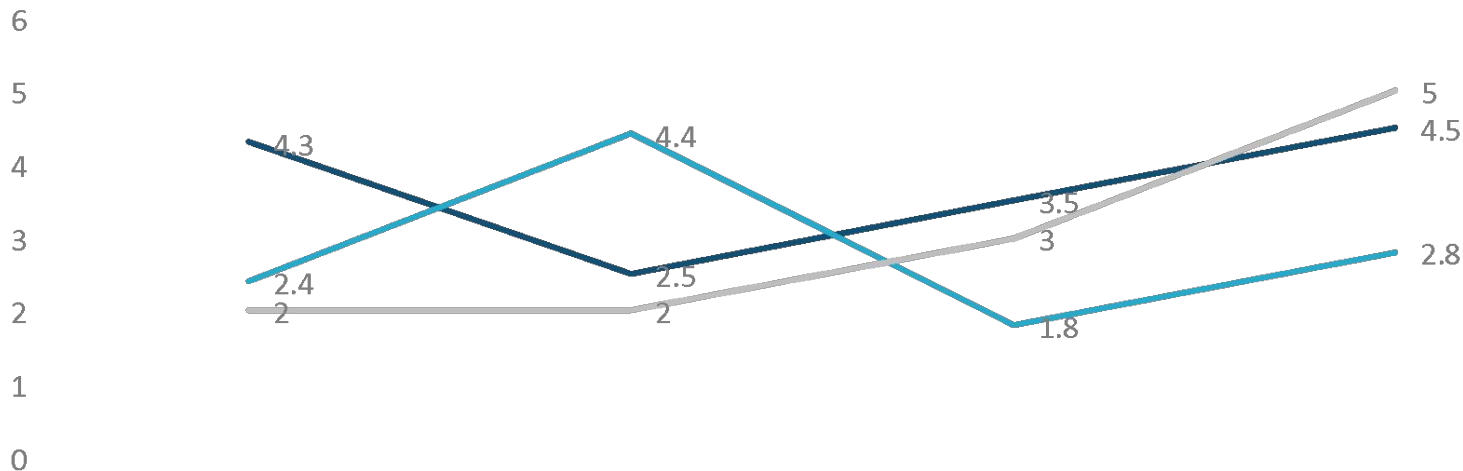
Lorem ipsum dolor sit amet,  
consectetur adipiscing elit.





# Sharp line chart

PUT YOUR TITLE HERE



## TITLE EXAMPLE

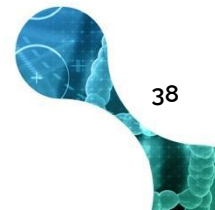
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## TITLE EXAMPLE

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## TITLE EXAMPLE

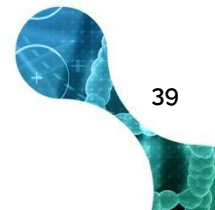
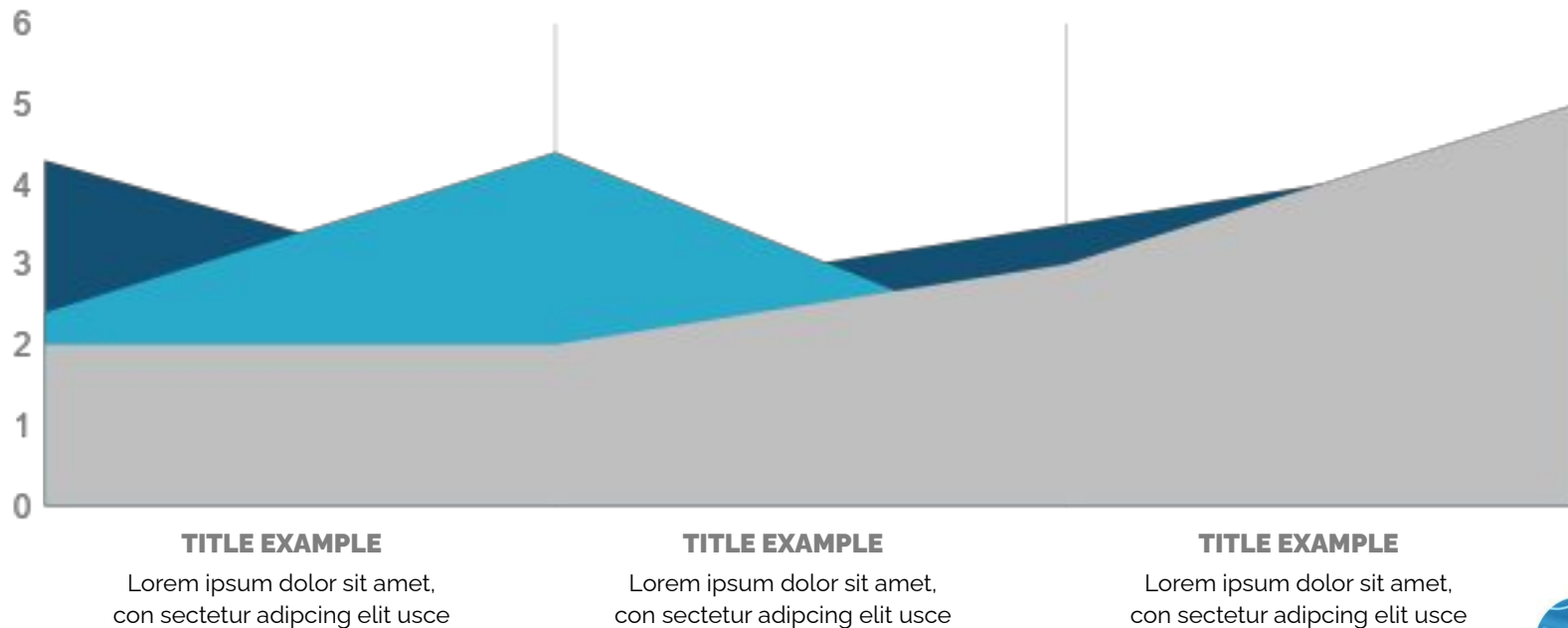
Lorem ipsum dolor sit amet,  
consectetur adipiscing elit.





# Area chart

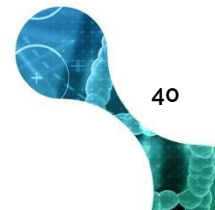
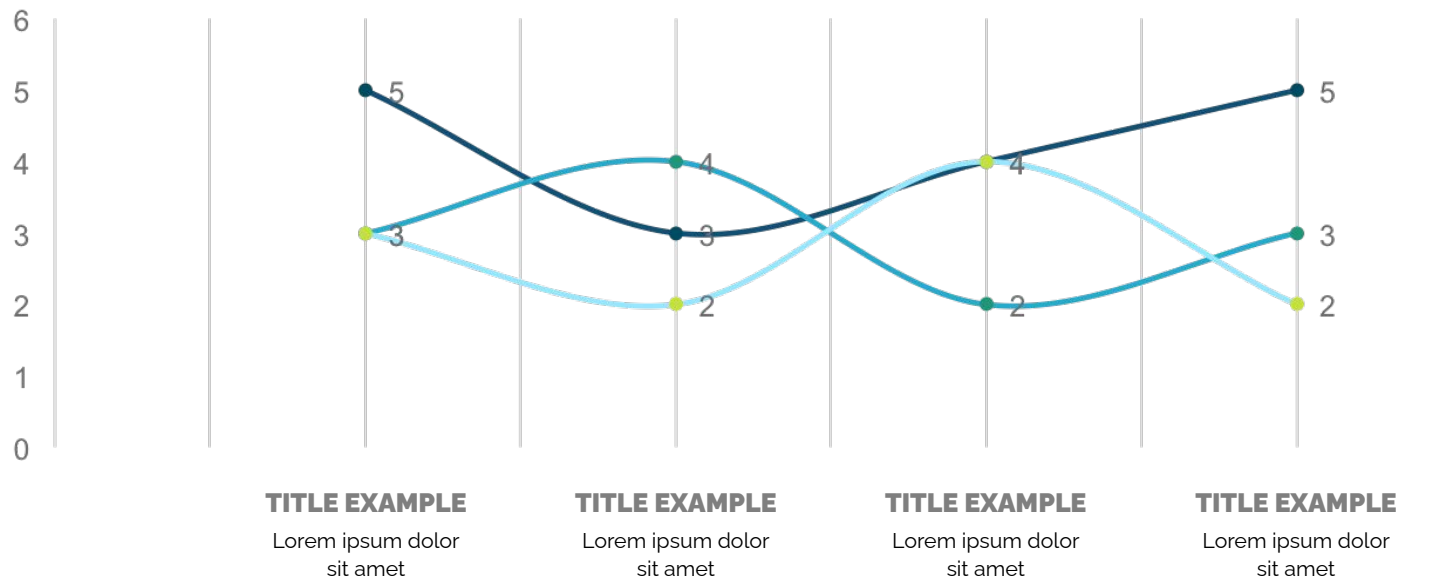
PUT YOUR TITLE HERE





# Curve line chart

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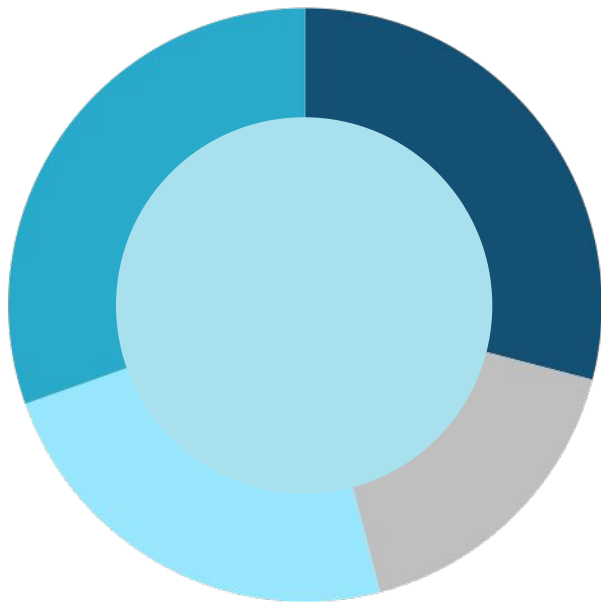






# Pie chart

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## TITLE EXAMPLE

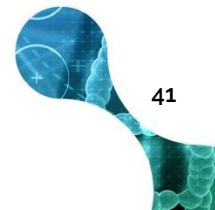
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## TITLE EXAMPLE

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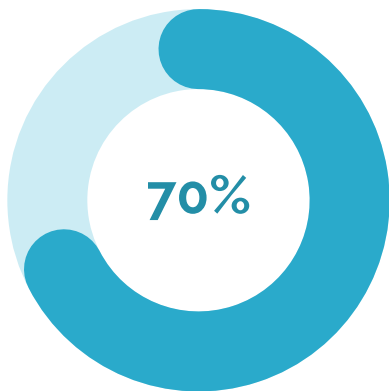
# Timeline one

PUT YOUR TITLE HERE



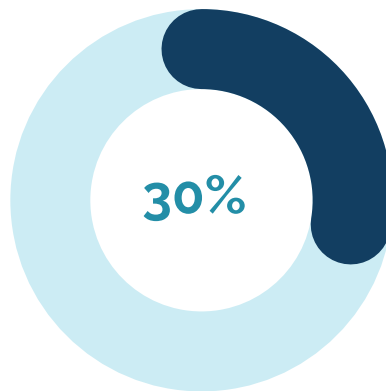
## TITLE EXAMPLE HERE

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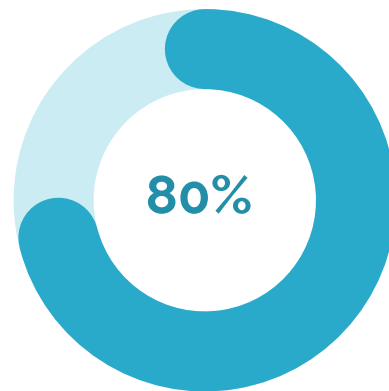
## TITLE EXAMPLE HERE

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Fusce diam tortor, mattis quis.



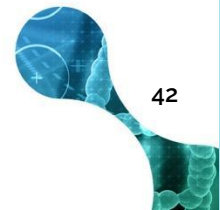
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## TITLE EXAMPLE HERE

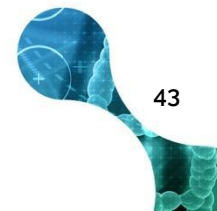
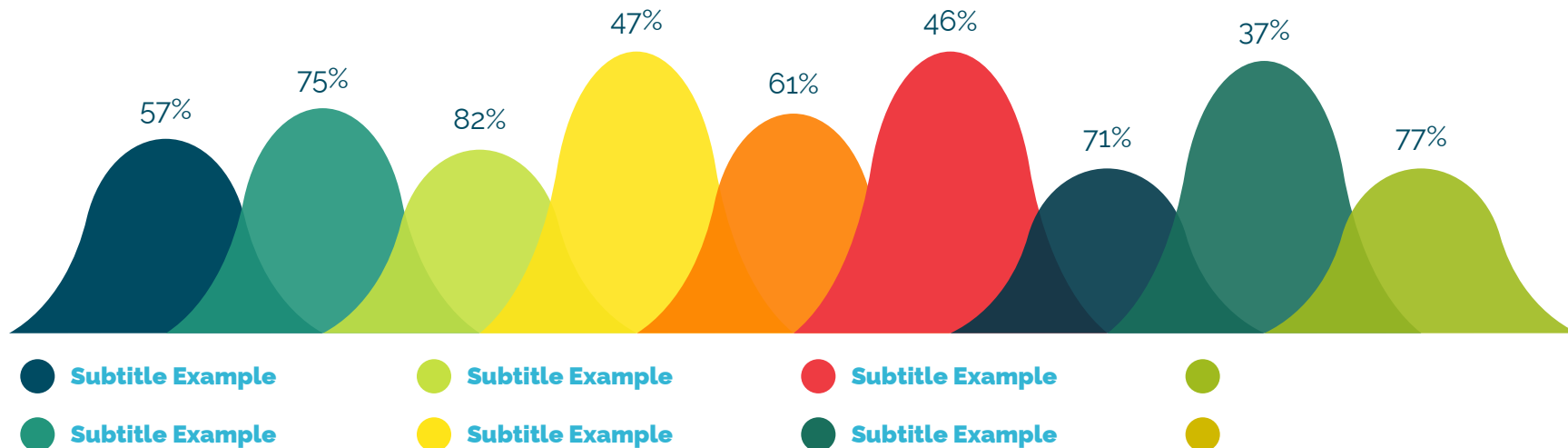
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# Waves

PUT YOUR TITLE HERE





# Reach goals

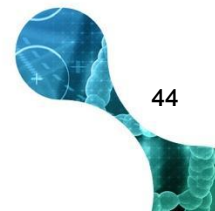
SUBTITLE EXAMPLE HERE

01

02

03

04



# Resources



*The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825111.*



# More than see you

TEXT WITH IMAGE PLACEHOLDER

- Lorem ipsum dolor sit amet, consectetur adipiscing elit. Fusce diam tortor, mattis quis dapibus vitae, euismod non purus.
  - Maecenas ut lacus nec mauris feugiat tristique et in metus. Duis congue eros vel lectus semper semper.
    - Nullam finibus nisl ut ligula vestibulum, ut semper ex suscipit.

