Classifying CIFAR-10 with CNN and Influence Functions.

SC1015 Project

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01 Problem Definition

Problem identified, Datasets used

02 Exploratory Data Analysis

Analyze and Summarize data sets to understand their Main Features

03 Data Modelling

Classifying images from the CIFAR-10 dataset

04 Influence & Insight

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01

Problem Definition

What are the problems we identified?
What are the datasets we utilised?

Problem Identified

How can we improve the efficiency of image classification algorithms through deeper analysis of of each image?

Introduction

The objective of this project is to classify images from the CIFAR-10 dataset into one of 10 possible classes and analyze the influence of individual images on the model's classification performance

Dataset Utilised

We pull the CIFAR-10 Dataset from the PyTorch Datasets Library.

In [4]:

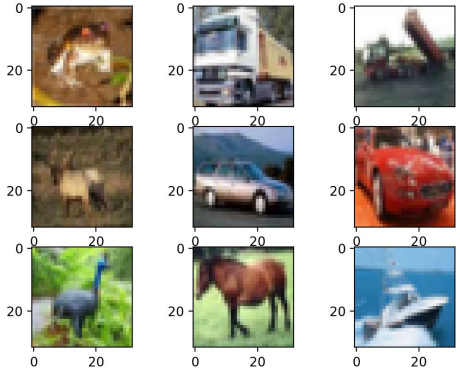
```
import torch
import torchvision as tv
from torchvision.datasets import CIFAR10
from torchvision.transforms import transforms
from torch.utils.data import DataLoader
import matplotlib.pyplot as plt
import numpy as np
```

In [15]:

```
# Load the test set without applying normalization
test_set = CIFAR10(root='./data', train=True, download=True, transform=transforms.ToTensor())

# Set batch size of x
test_loader = DataLoader(test_set, batch_size=len(test_set), shuffle=False)
```

Airplane	Dog
Automobile	Frog
Bird	Horse
Cat	Ship
Deer	Truck



60,000 RGB Images

10 Classes of 6,000 Images

32 x 32 Pixels

Data Preparation

We normalised the images to bring the **mean towards 0** and the **standard deviation towards 1.**

In [8]:

```python
# Iterate over the test set to compute the mean and standard deviation
mean = 0.
std = 0.
num_samples = 0.
for data, _ in test_loader:
    batch_samples = data.size(0)
    data = data.view(batch_samples, data.size(1), -1)
    mean += data.mean(2).sum(0)
    std += data.std(2).sum(0)
    num_samples += batch_samples

mean /= num_samples
std /= num_samples

print("Mean:", mean)
print("Std:", std)
```

```
Mean: tensor([0.4914, 0.4822, 0.4465])
Std: tensor([0.2023, 0.1994, 0.2010])
```

In [5]:

```python
# Transform data into Tensor form (Torch.Tensor)
transform = transforms.Compose( [transforms.ToTensor(),
    transforms.Normalize(mean=[0.4914, 0.4822, 0.4465], std=[0.2023, 0.1994, 0.2010])])

# Load the test set and create a dataloader
test_set = CIFAR10(root='./data', train=True, download=True, transform=transform)

# Set batch size of x
test_loader = DataLoader(test_set, batch_size=len(test_set), shuffle=False)
```

```
Mean: tensor([-1.5628e-06, -2.0851e-04,  1.5382e-04])
Std: tensor([1.0000, 1.0001, 0.9998])
```

Mean is now **~0**

- Reduce bias towards any pixel value range

Standard Deviation is now **~1**

- Reduce sensitivity to variation in pixel values

This is to set up for the CNN.

02

Exploratory Data Analysis

Analyze and Summarize data sets to understand their Main Features

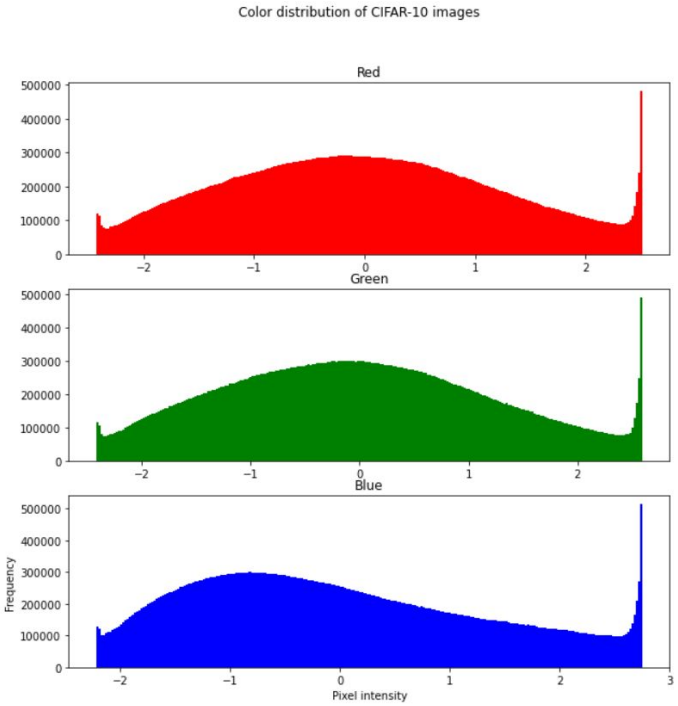
WHAT DOES THE DATA SAY [OK]

Color Distribution Plot

```python
# Get the RGB pixel values of all images
r = []
g = []
b = []
for image, _ in test_set:
    r.append(image[0].numpy().ravel())
    g.append(image[1].numpy().ravel())
    b.append(image[2].numpy().ravel())

# Create a histogram for each color channel
fig, axs = plt.subplots(3, 1, figsize=(10, 10))
axs[0].hist(np.concatenate(r), bins=256, color='r')
axs[1].hist(np.concatenate(g), bins=256, color='g')
axs[2].hist(np.concatenate(b), bins=256, color='b')

# Set the title and axis labels
fig.suptitle('Color distribution of CIFAR-10 images')
axs[0].set_title('Red')
axs[1].set_title('Green')
axs[2].set_title('Blue')
plt.xlabel('Pixel intensity')
plt.ylabel('Frequency')
# Show the plot
plt.show()
```



Analysis

Check whether there is a **dominance of certain colors/brightness** of pixels

Insights

Centered ~0
- dataset's colors are well balanced
- pixels well normalised.

Outlier (Blue)

Bias towards lighter blue images, possibly due to lighting

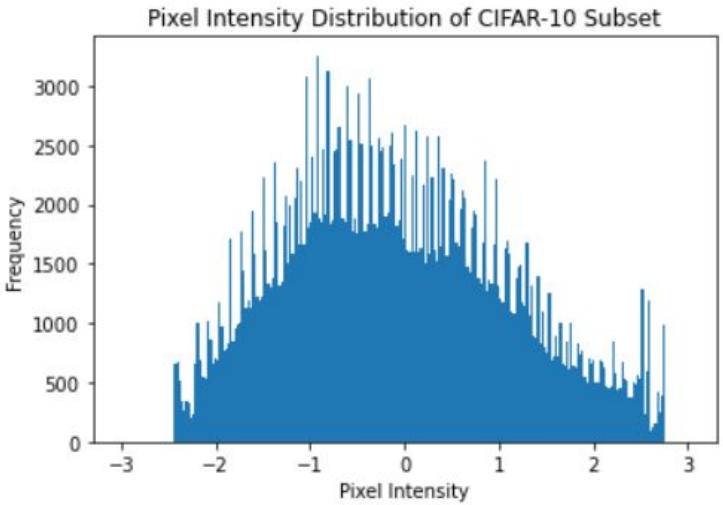
Pixel Intensity Distribution

In [11]:

```
# Get random subset of 100 images
subset_indices = np.random.choice(len(test_set), size=100, replace=False)

# Concatenate image tensors into one array
subset_images = np.concatenate([test_set[i][0].numpy().ravel() for i in subset_indices])

# Plot intensity distribution
plt.hist(subset_images, bins=256, range=(-3, 3))
plt.title('Pixel Intensity Distribution of CIFAR-10 Subset')
plt.xlabel('Pixel Intensity')
plt.ylabel('Frequency')
plt.show()
```



Analysis

Brightness of each pixel in the images to **check for dominance/imbalance** of pixel values

Insights

Centered -1 to 0

- normalisation managed to reduce the effect of variation in brightness in images

- data is distributed evenly around the mean value of 0.

PCA Plot Distribution

Principal Component Analysis

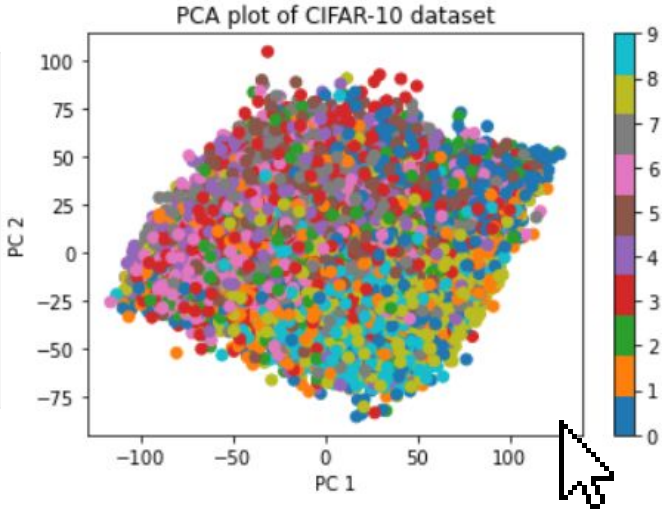
Find principal components (directions with most variation) and plot a scatter plot to determine patterns/clusters in data.

```python
from sklearn.decomposition import PCA

# Extract data and labels
data = np.array([x.numpy().flatten() for x, _ in test_set])
labels = np.array([y for _, y in test_set])

# Perform PCA to reduce dimensionality to 2 dimensions
pca = PCA(n_components=2)
data_pca = pca.fit_transform(data)

# Plot the results
plt.scatter(data_pca[:, 0], data_pca[:, 1], c=labels, cmap='tab10')
plt.colorbar()
plt.xlabel('PC 1')
plt.ylabel('PC 2')
plt.title('PCA plot of CIFAR-10 dataset')
plt.show()
```



Analysis

Examine whether there are **distinct groups of images** in the data – and whether classes overlap.

Insights

Visible distinction between classes of images

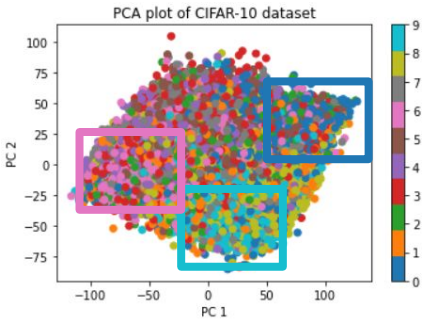
- well defined classes
- easier for CNN to distinguish between images

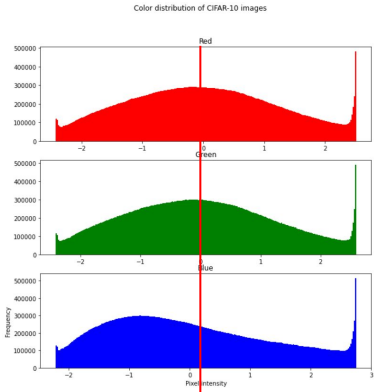
- normalisation is effective

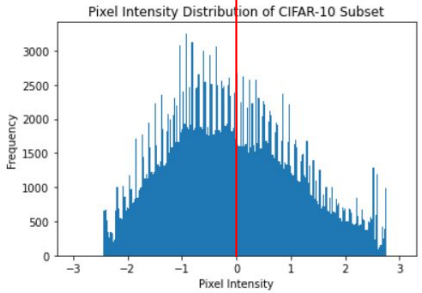
Conclusion of EDA

Normalisation done during Data Preparation was **good in reducing bias/variation** in data.

This **reduces the complexity of image classification** and **potentially improves the accuracy** of the Convolutional Neural Network that we will implement.







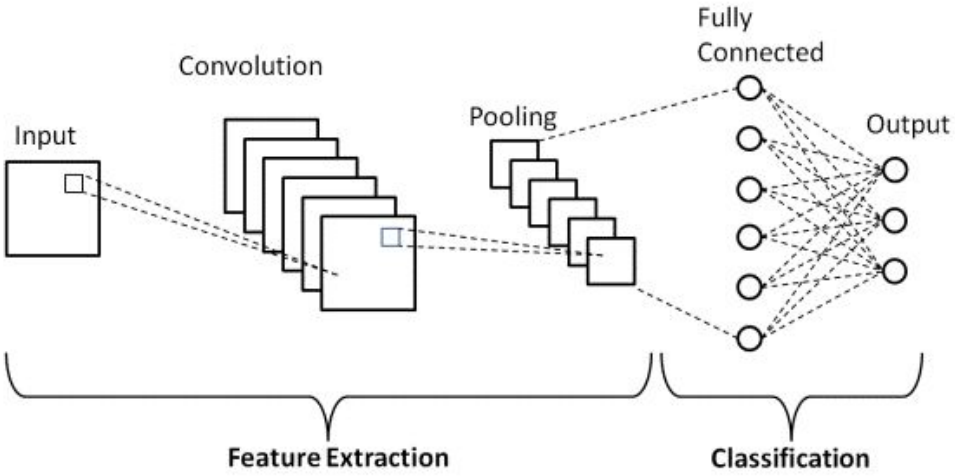
03

Data Modeling

Classifying images from the CIFAR-10 dataset

Convolutional Neural Network

- Commonly used for image classification
- Consists of several layers
  - Convolution layer
  - Pooling layer
  - Fully connected layer



Convolutional Neural Network

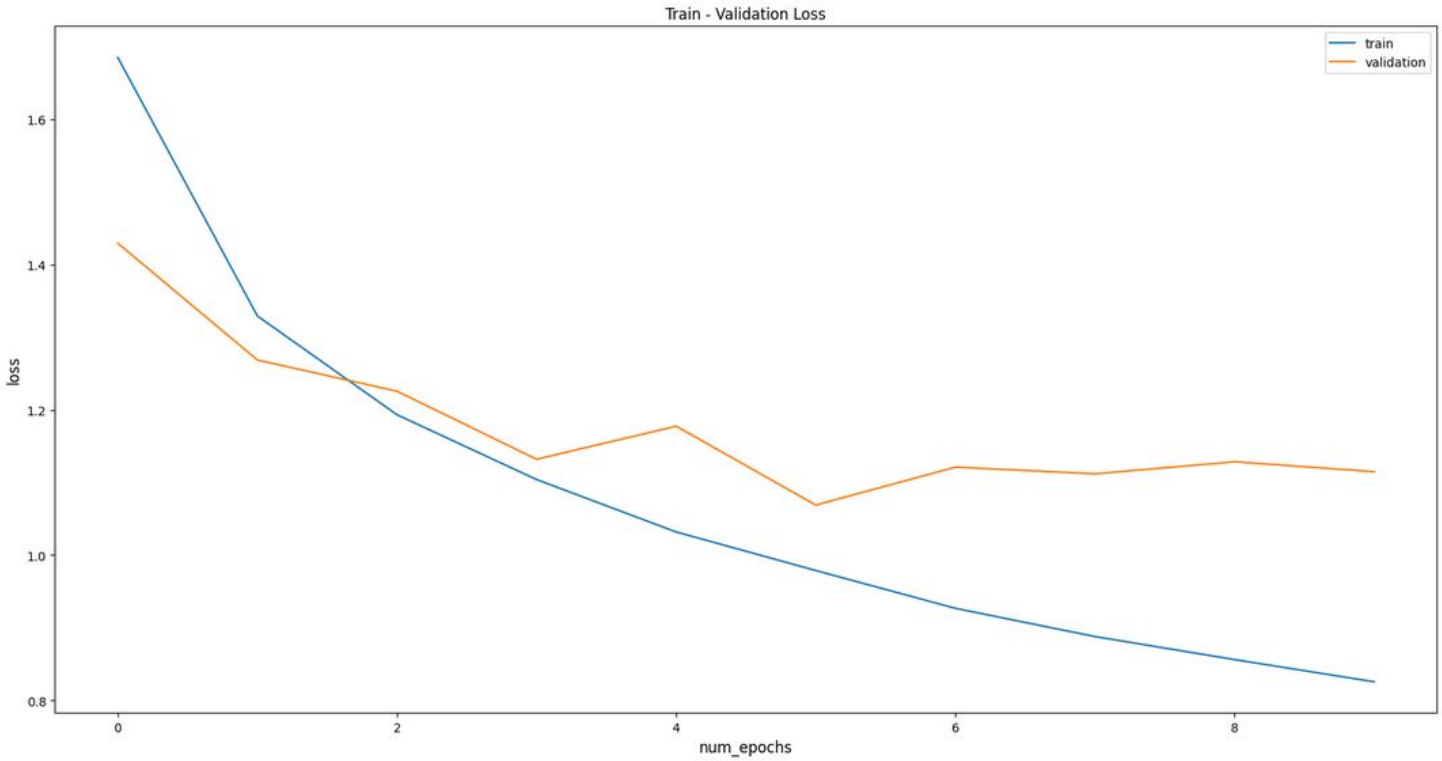
- 2 convolution layers, 1 pooling layer, 3 fully connected layers

- Forward function
  - Forward pass of the model
  - X is constantly transformed in the layers

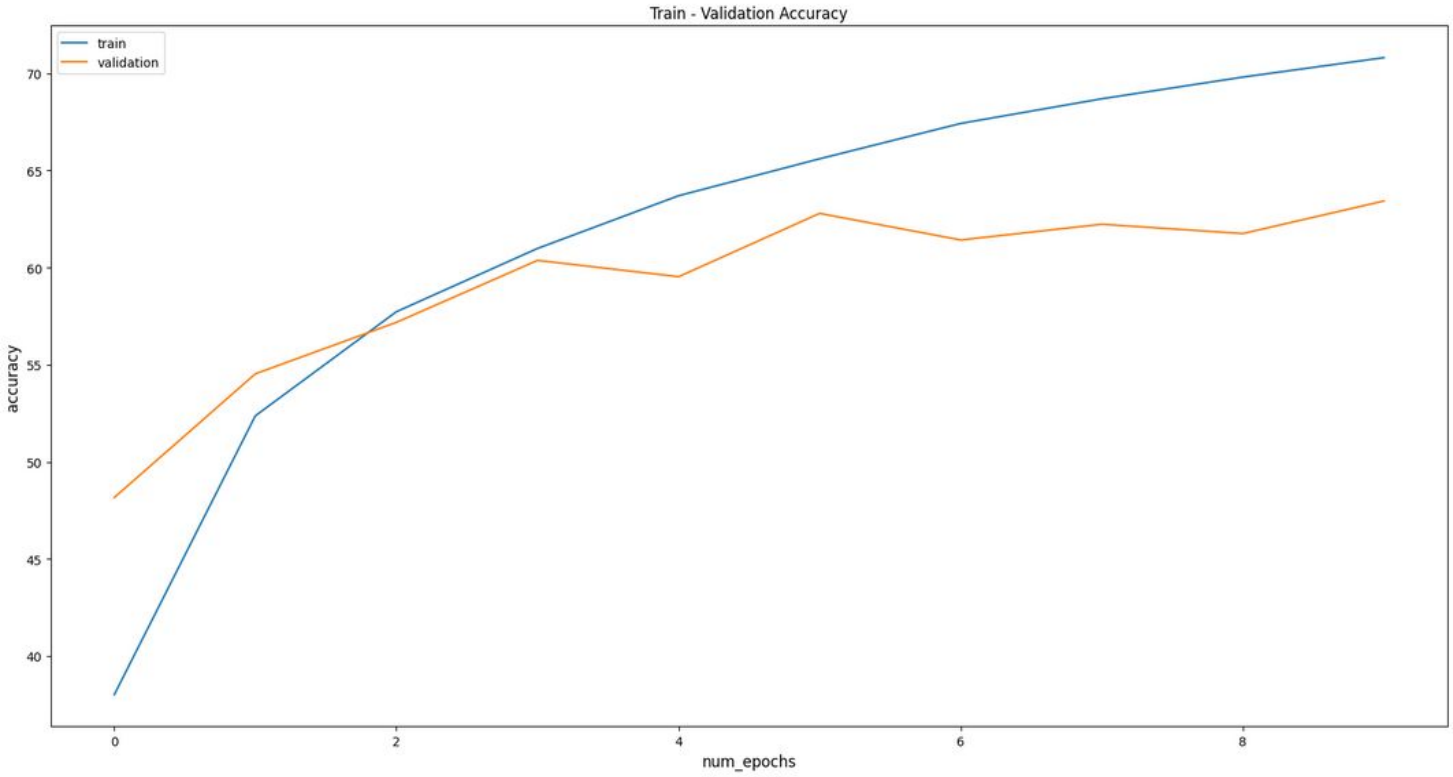
```python
class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()
        self.conv1 = nn.Conv2d(3, 6, 5)
        self.pool = nn.MaxPool2d(2, 2)
        self.conv2 = nn.Conv2d(6, 16, 5)
        self.fc1 = nn.Linear(16 * 5 * 5, 120)
        self.fc2 = nn.Linear(120, 84)
        self.fc3 = nn.Linear(84, 10)

    def forward(self, x):
        x = self.pool(F.relu(self.conv1(x)))
        x = self.pool(F.relu(self.conv2(x)))
        x = x.view(-1, 16 * 5 * 5)
        x = F.relu(self.fc1(x))
        x = F.relu(self.fc2(x))
        x = self.fc3(x)
        return x
```

Train/Validation Loss

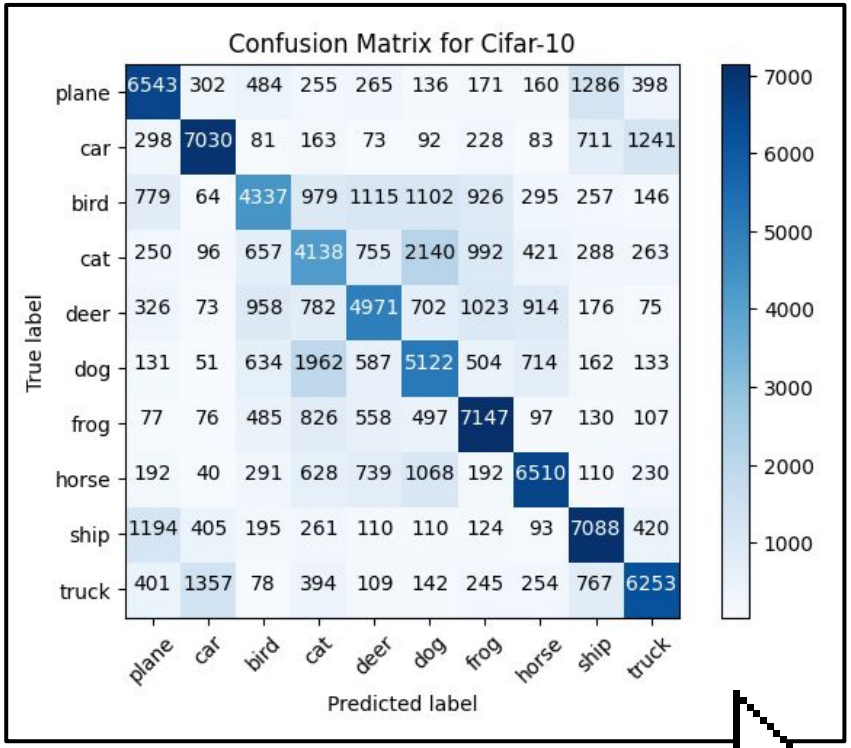


Train/Validation Accuracy



Confusion Matrix

- 10×10 table for correct hits vs incorrect hits
- Average accuracy of around 60%
- Useful to see which kind of images are harder to predict



04

Influence & Insight

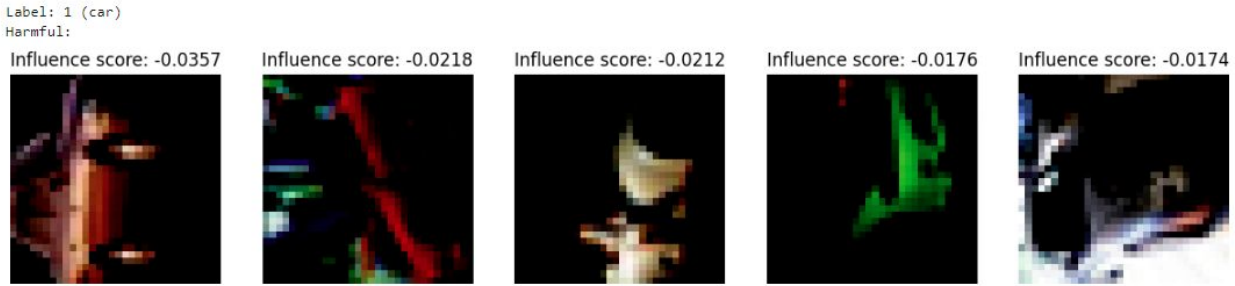
Results and Findings

Plane

Label: 0 (plane)
Harmful:

Helpful:

Car


Label: 1 (car)
Harmful:
Influence score: -0.0357
Influence score: -0.0218
Influence score: -0.0212
Influence score: -0.0176
Influence score: -0.0174

Helpful:
Influence score: 0.0159
Influence score: 0.0106
Influence score: 0.0104
Influence score: 0.0100
Influence score: 0.0095

Plane

Label: 0 (plane)
Harmful:

Helpful:

Conclusion

-Examining individual image contributions is significant

-Identifying potential areas for improvement is important

- Insights can enhance image classification systems.

Thanks!

Thanks!

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04

Modeling, virtual environments and simulation

You can enter a subtitle here if you need it

Job title examples

App developer

Mercury is the closest planet to the Sun and the smallest

Systems engineer

Venus has a beautiful name, but also high temperatures

Software engineer

Earth is the third planet from the Sun and has life

Computer programmer

Despite being red, Mars is actually a cold place

Professional areas

	Freelancer	Employee
Professional, scientific and tech.	✓	
Publishing industries		✓
Electronic product manufacturing	✓	
Insurance and related activities		✓
Management of companies	✓	

What courses to take?

Computational

Mercury is the smallest planet

Computer app

Jupiter is the biggest planet

Development

Despite being red, Mars is a cold place

Programming

Venus has a beautiful name

Mathematics

Neptune is far away from Earth

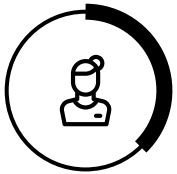
Statistics

Earth is a planet that has life

Labor insertion

Gender

60%



40%

Age

Women ● Men ●

Interests

Follow the link in the graph to modify its data and then paste the new one here. **For more info, click here**

“This is a quote, words full of wisdom that someone important said and can make the reader get inspired.”

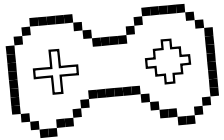
—Someone Famous

The slide title goes here!

Do you know what helps you make your point clear? Lists like this one:

- They’re simple
- You can organize your ideas clearly
- You’ll never forget to buy milk!

And the most important thing: the audience won’t miss the point of your presentation



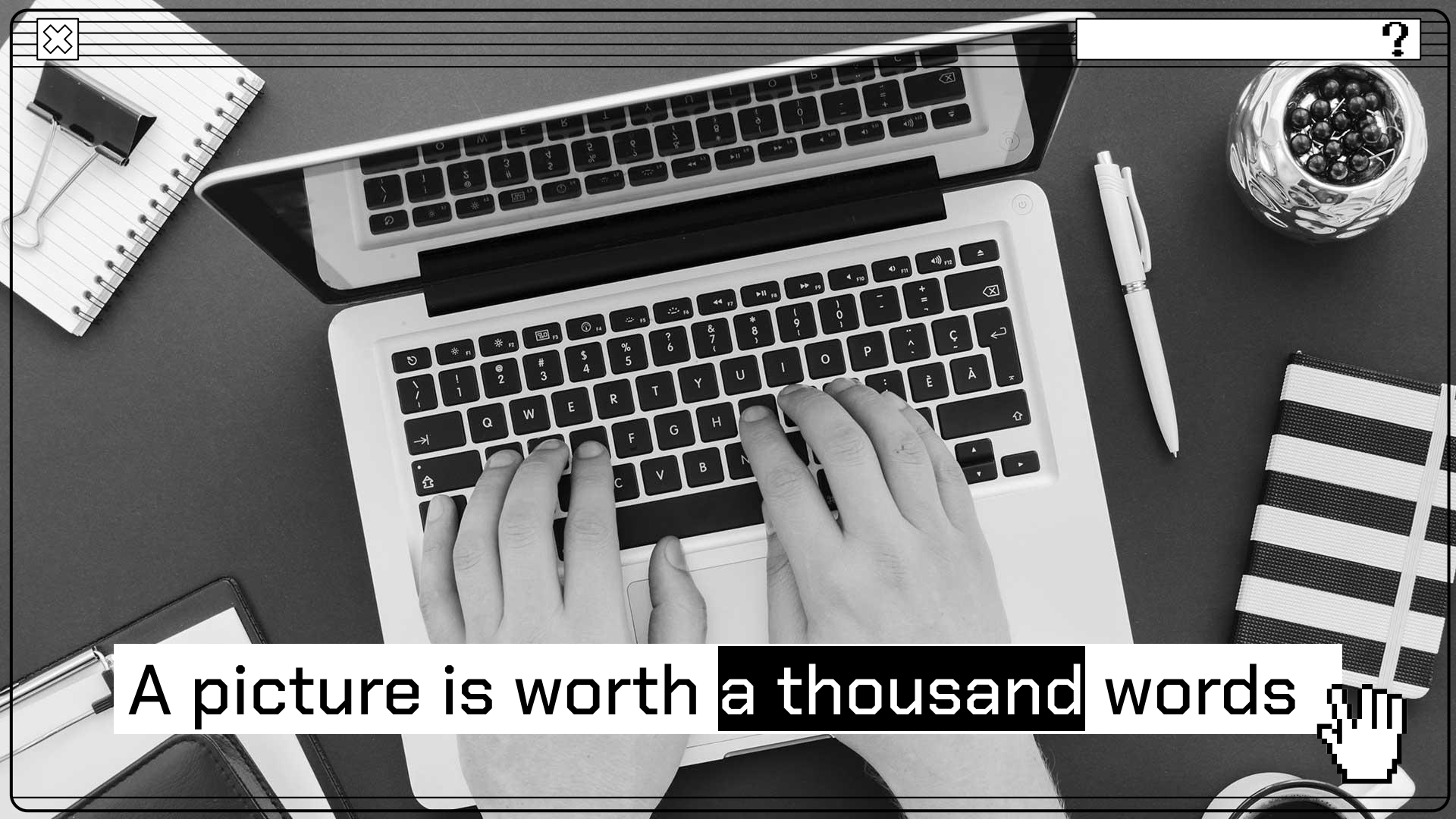
Explore computer science

Theory

Mercury is the closest planet to the Sun and the smallest in the Solar System

Design

Despite being red, Mars is actually a cold place. It’s full of iron oxide dust


?
A picture is worth a thousand words

Whoa!

This can be the part of the presentation where you introduce yourself, write your email…

Computer graphics packages

Mercury

It’s the closest planet to the Sun and the smallest

Venus

Venus is the second planet from the Sun

Mars

Despite being red, Mars is actually a cold place

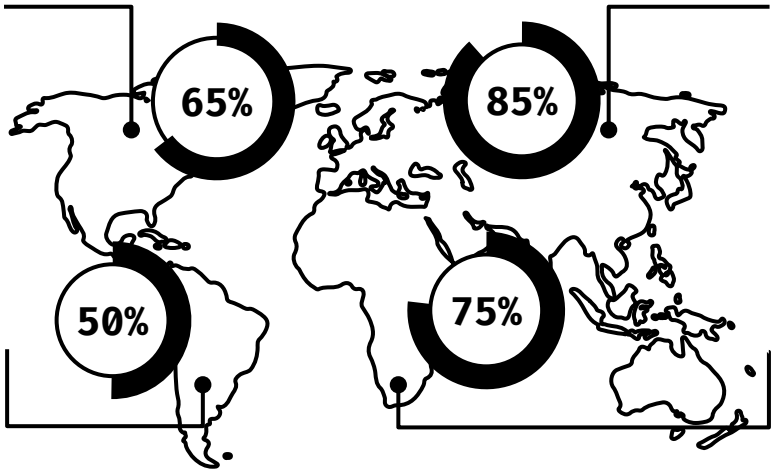
Where are professionals needed?

Venus

Venus has a beautiful name

Mars

Mars is a very cold place



Jupiter

Jupiter is the biggest planet

Saturn

Saturn is the ringed planet

What are other related majors?

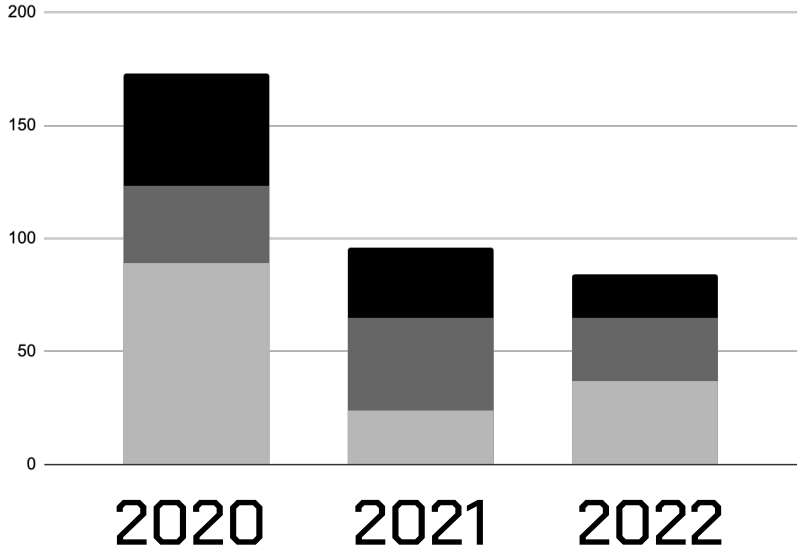
Option A

- Saturn is a gas giant and has several rings
- Neptune is the farthest planet from the Sun
- The Sun is the star at the center of the Solar System

Option B

- Venus is the second planet from the Sun
- Despite being red, Mars is a cold place
- Jupiter is the biggest planet in the Solar System

Graph about database admin.



Follow the link in the graph to modify its data and then paste the new one here. **For more info, click here**

Mercury

It's the closest planet to the Sun

Mars

Mars is actually a very cold place

Neptune

Neptune is far away from Earth

150,000

Big numbers catch your audience’s attention

9h 55m 23s

Jupiter's rotation period

333,000

The Sun’s mass compared to Earth’s

386,000 km

Distance between Earth and the Moon

What courses to take?

Accounting

Mercury is a very small planet

Networks

Venus has a beautiful name

Programming

Mars is actually a very cold place

Logic

Jupiter is the biggest planet

Semantics

Saturn is the ringed planet

Architecture

Neptune is far away from Earth

Our major program

Despite being red, Mars is cold

It’s the closest planet to the Sun

Mars

Mercury

2022

2023

2024

2025

Jupiter

It’s the biggest planet of them all

Saturn

It’s composed of hydrogen and helium

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4. A **thanks slide**, which you must keep so that proper credits for our design are given.
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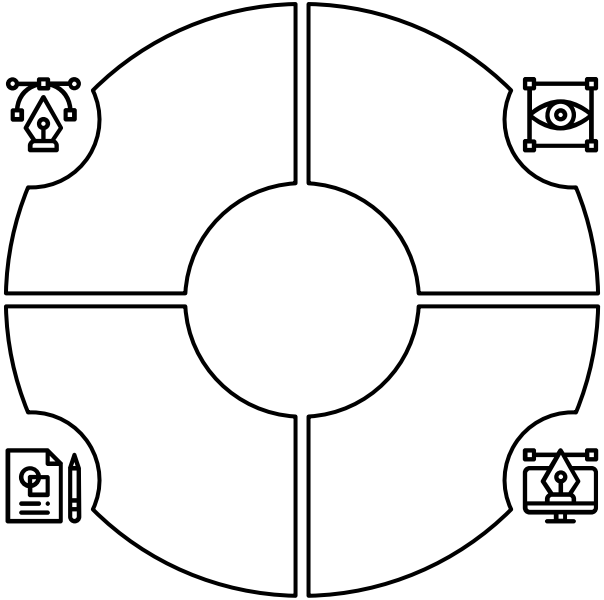
Best modeling courses

Venus

Venus is the second planet from the Sun

Saturn

Saturn is a gas giant and has several rings



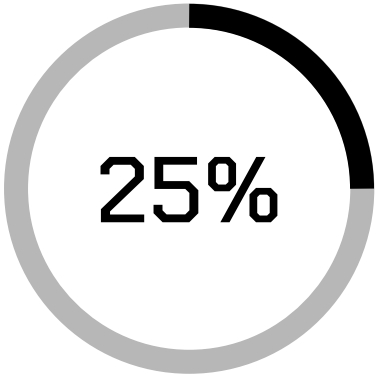
Jupite

It’s the biggest planet in the Solar System

Mercury

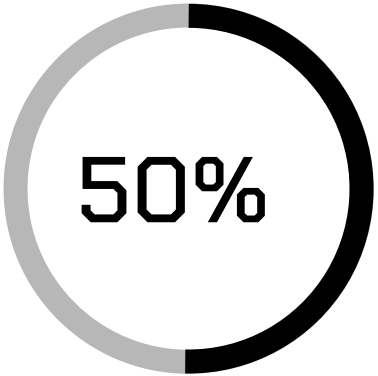
Mercury is the closest planet to the Sun

Employments in this sector



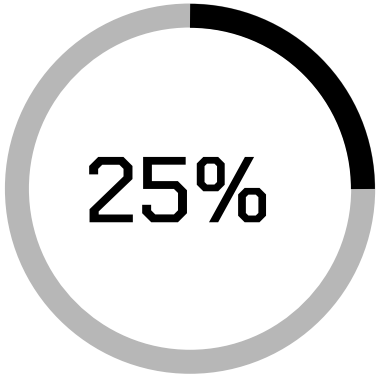
Modeling

Mars is actually a very cold place



Virtual

Neptune is far away from Earth



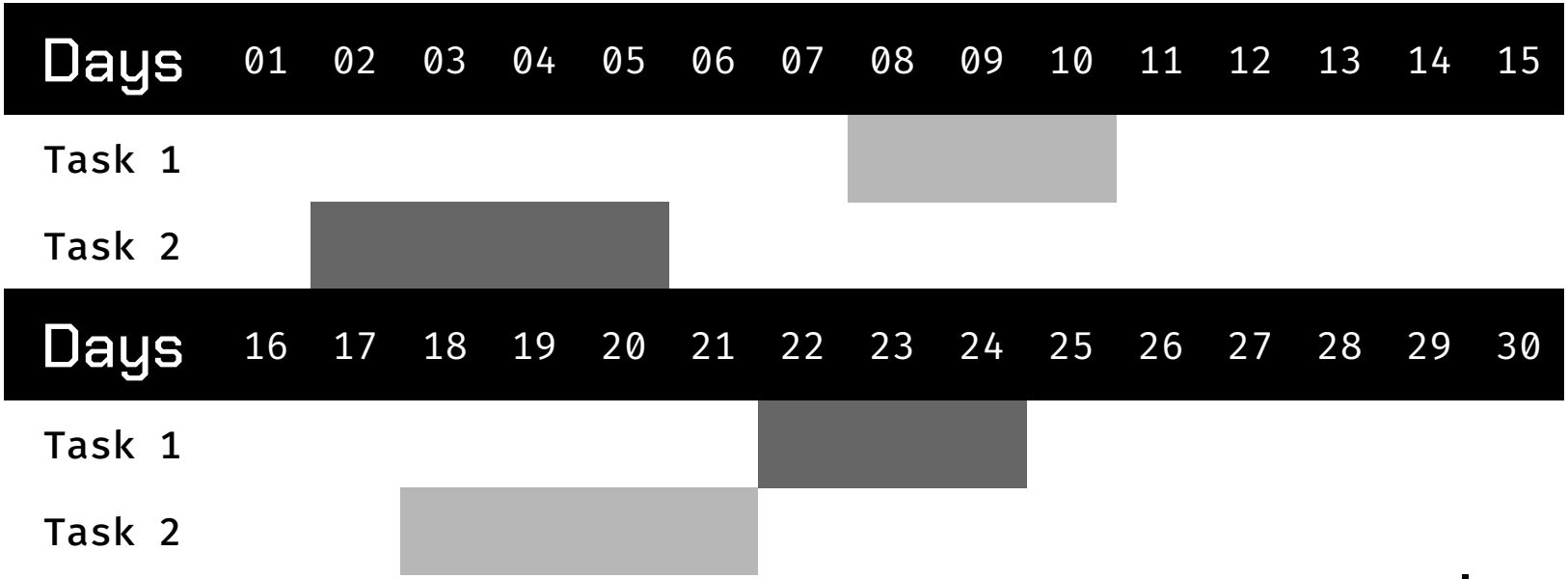
Simulation

Mercury is quite a small planet

Awesome

words

Study schedule



Available

No available

A picture always reinforces the concept

Images reveal large amounts of data, so remember: use an image instead of a long text. Your audience will appreciate it

Our department

Timmy Jimmy

You can replace the image on the screen with your own

Susan Bones

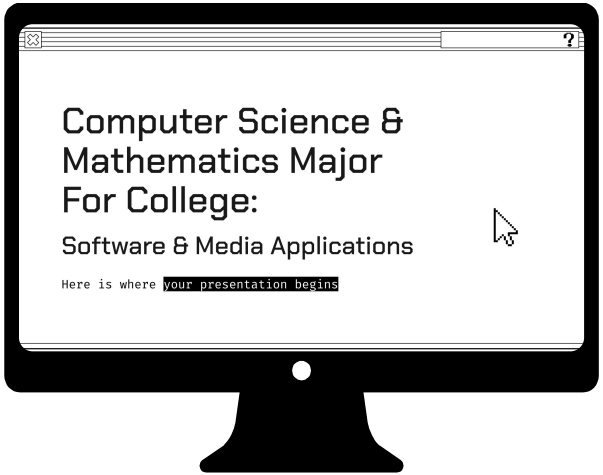
You can replace the image on the screen with your own

John Doe

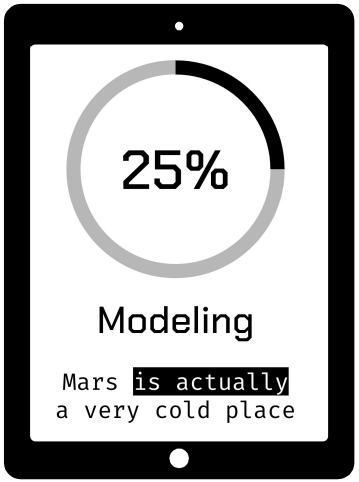
You can replace the image on the screen with your own

Enrollment platform

You can replace the image on the screen with your own work. Just right-click on it and select “Replace image”



Studying app



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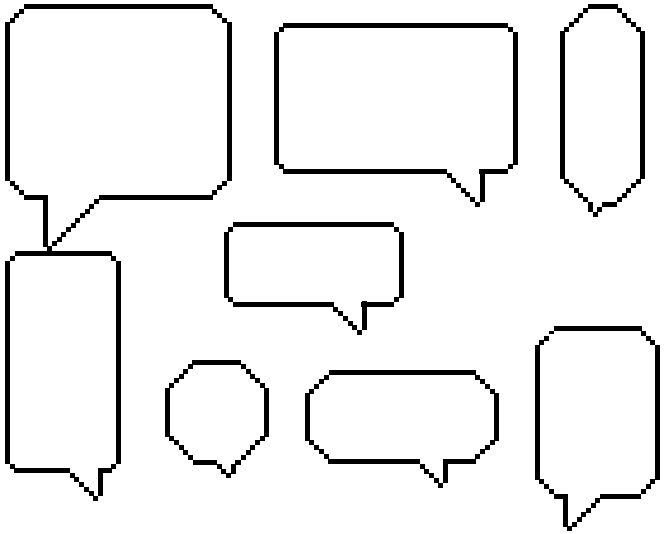
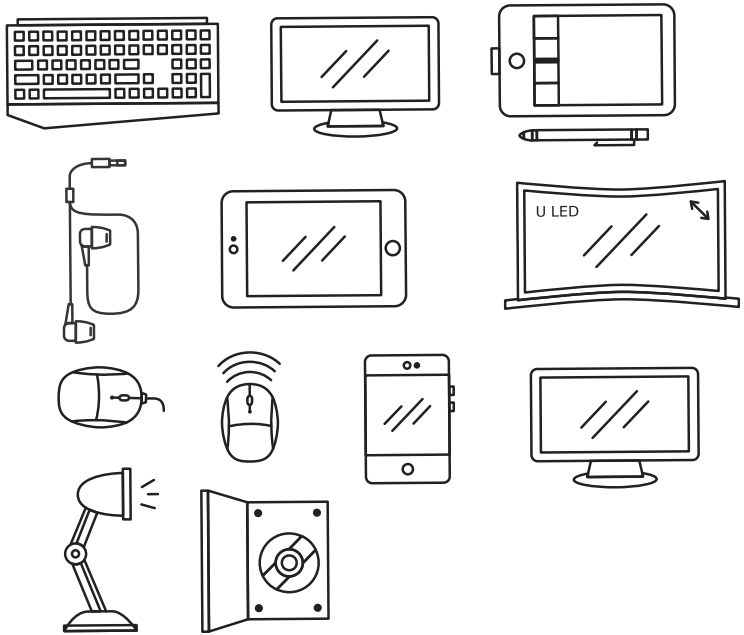
Messaging app

You can replace the image on the screen with your own work. Just right-click on it and select “Replace image”

Alternative resources





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Photos

- Young woman browsing laptop on road trip
- High angle of woman drawing at desk with laptop
- Flat lay desk with laptop and glasses

Vectors

- Black friday background with black and white elements
- Modern cursor set
- Multimedia icons
- Set of white speech bubbles in pixel art style

Resources

Did you like the resources we used in this template? Get them for free at our other websites:

Photos

- Laptop Free
- White keyboard of modern laptop
- Medium shot colleagues back to office

Vectors

- Set of white speech bubbles in pixel art style
- Pixel gaming youtube channel art
- Pixel mouse cursors pointer, arrow and wait
- Vector pixel mouse cursors over white
- Vector pixel mouse cursors over white

Instructions for use

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Fonts & colors used

This presentation has been made using the following fonts:

Chakra Petch
(https://fonts.google.com/specimen/Chakra+Petch)

Fira Code
(https://fonts.google.com/specimen/Fira+Code)

#000000	#ffffff	#666666	#b7b7b7

Storyset

Create your Story with our illustrated concepts. Choose the style you like the most, edit its colors, pick the background and layers you want to show and bring them to life with the animator panel! It will boost your presentation. Check out how it works.

Pana

Amico

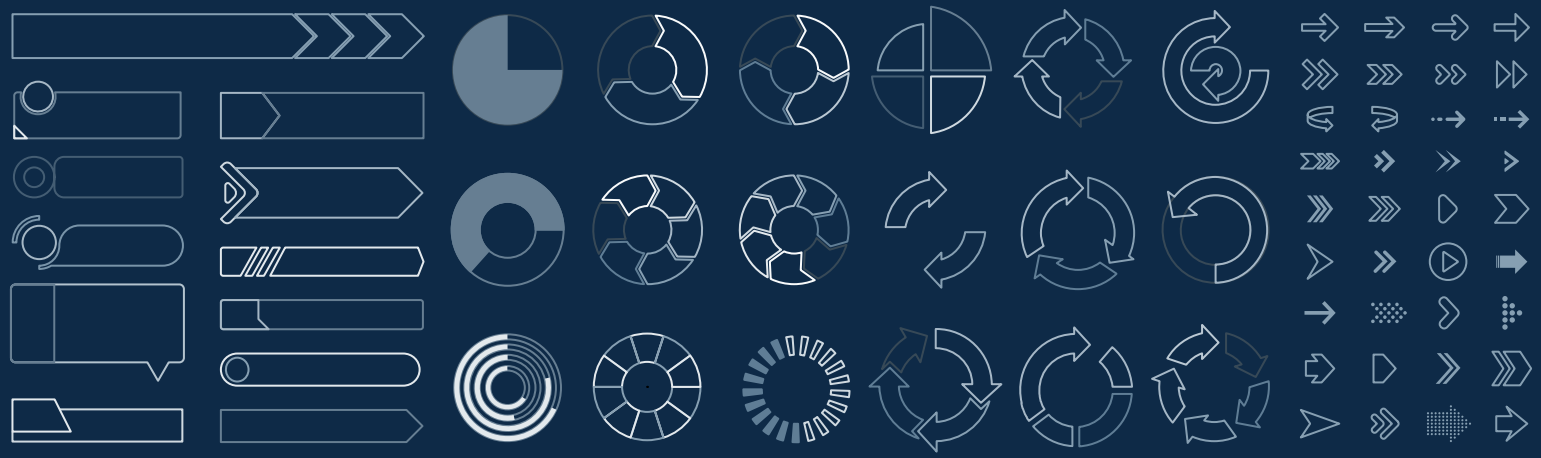
Bro

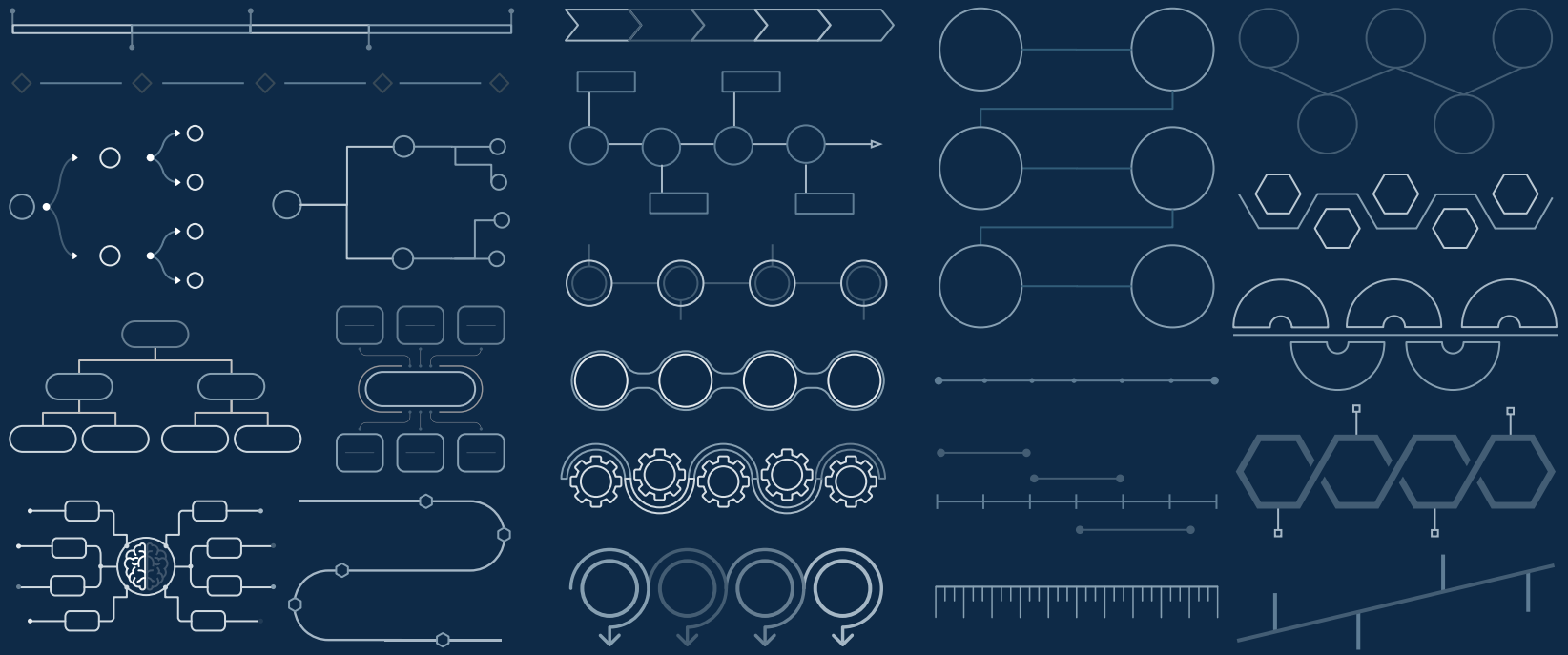
Rafiki

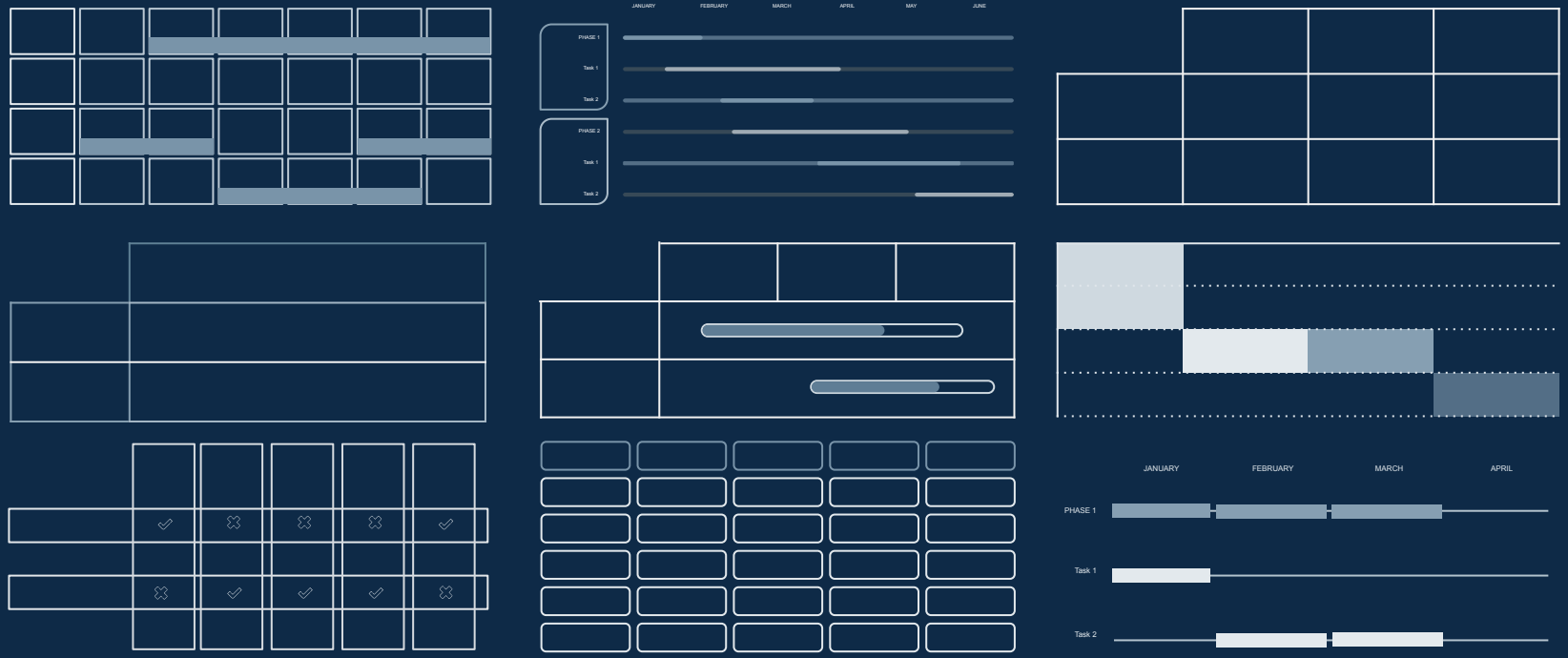
Cuate

Use our editable graphic resources...

You can easily resize these resources without losing quality. To change the color, just ungroup the resource and click on the object you want to change. Then, click on the paint bucket and select the color you want. Group the resource again when you're done. You can also look for more infographics on Slidesgo.






JANUARY
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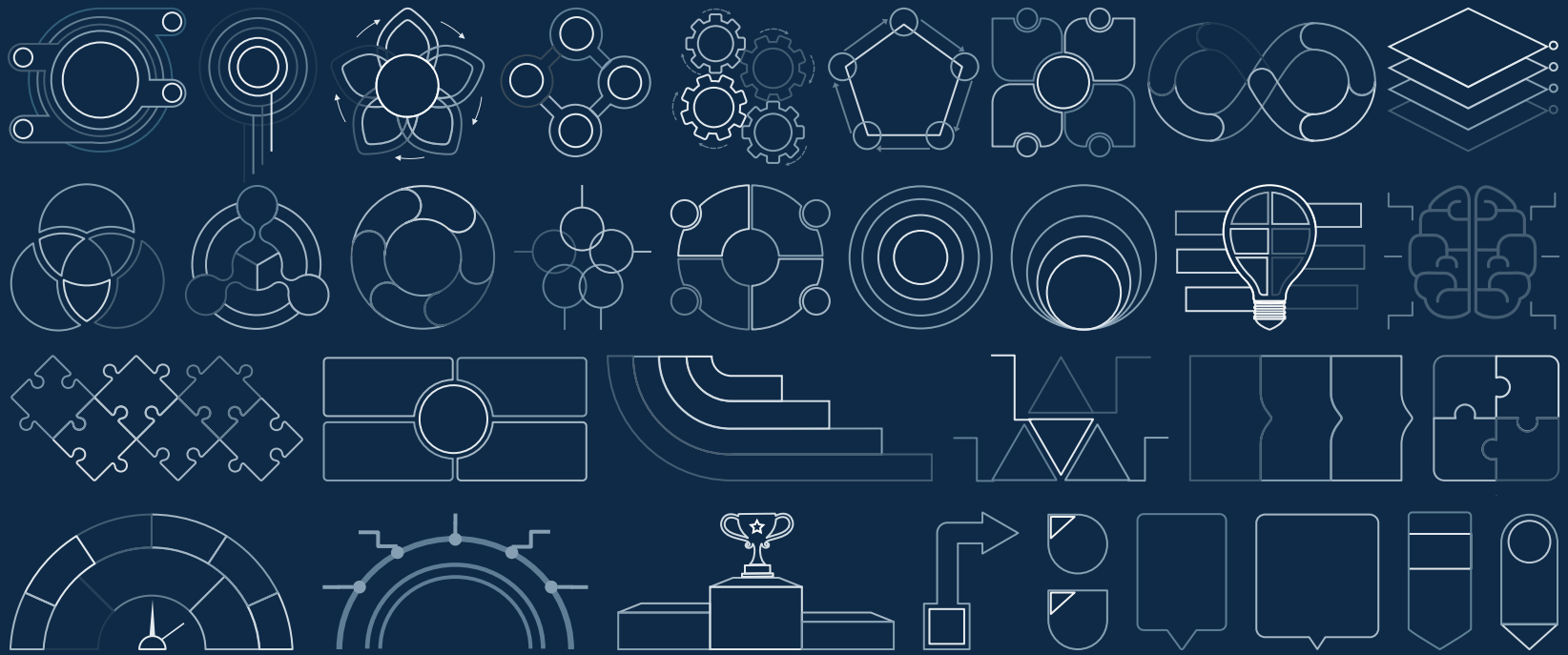

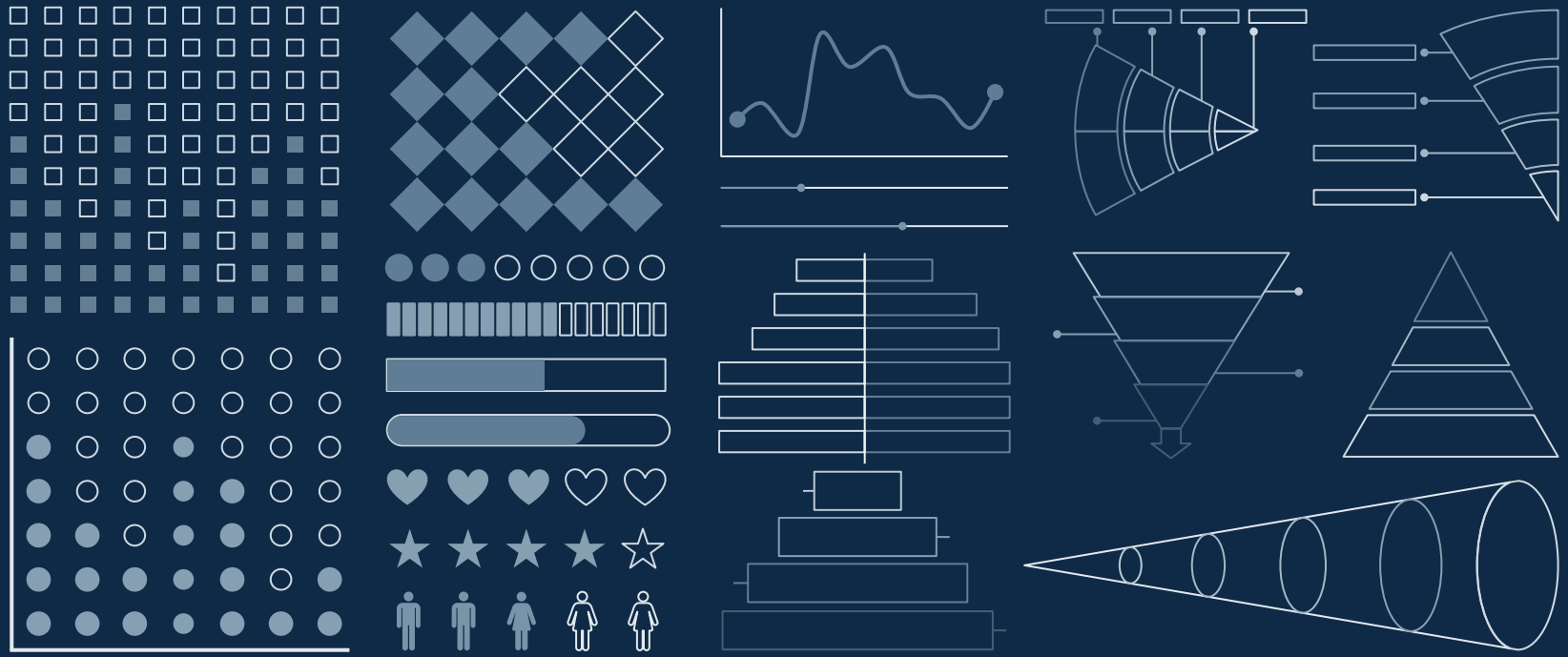

...and our sets of editable icons

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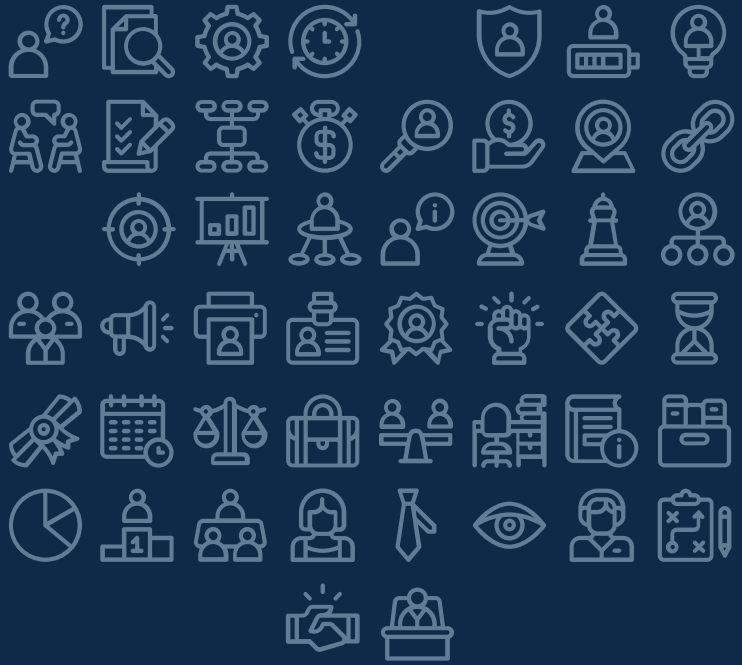
In Google Slides, you can also use Flaticon's extension, allowing you to customize and add even more icons.

Educational Icons

Medical Icons

Business Icons

Teamwork Icons



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