

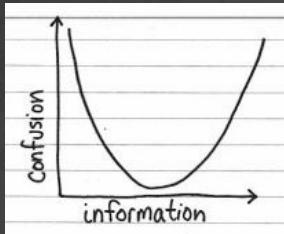


Spotify Music Recommendation Systems

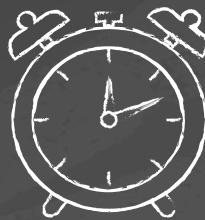
DSI23 Capstone Project by Raymond Oon



Why recommendation systems?



+



=



Too much info

Information overload prevent us from making good decisions

Too little time

Time is limited



RecSys will become norm

As a result, recommendation systems have become common in our everyday lives and will likely become a norm in the future.

Develop a Content-Based Recommendation that seeks to optimize the discovery of songs

Project Workflow



Data Scrapping Data Cleaning and ETL

- Dataset scrapped from Spotify Search API via spotipy library
- Transform and save in **Google Cloud**
- Automated using **Airflow**

Data Cleaning and EDA

- Drop Nulls
- Remove Duplicates
- Remove Outliers
- Feature Engineering

Pre-processing and Modelling

- Dummy Variables for Categorical features
- Normalize Float features
- Text Vectorization
- A/B Testing

Conclusions & Next Steps

Dataset



- Consists of information regarding songs released between 1930 and 2020
- Scrapped using the Spotify API (1000 results per year)
- Features can be broken into 2 groups:

Metadata

- Track Name
- Track Id
- Artist Name
- Artist Genre
- Release Date
- Year
- Popularity

Audio Features

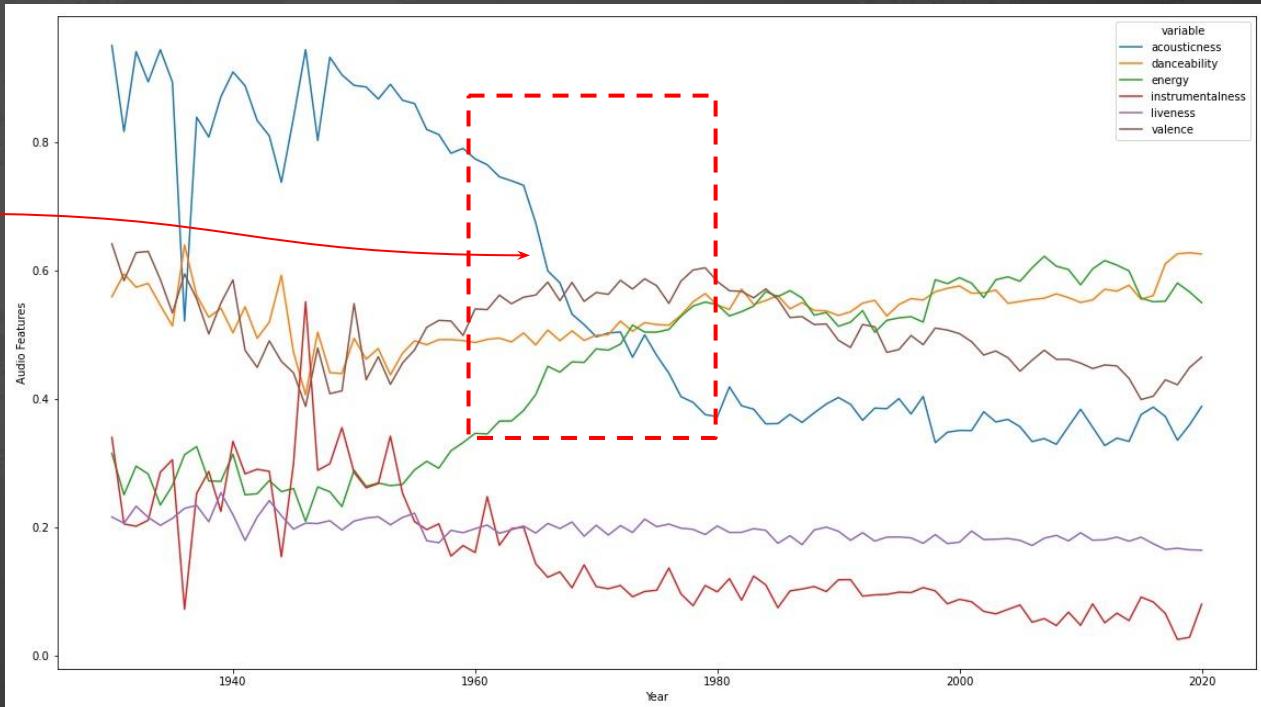
- Danceability
- Energy
- Key
- Loudness
- Mode
- Speechiness
- Acousticness
- Instrumentalness
- Valence
- Tempo

- After data cleaning, we are left with 74,030 rows

How have music tastes changed?

Insights

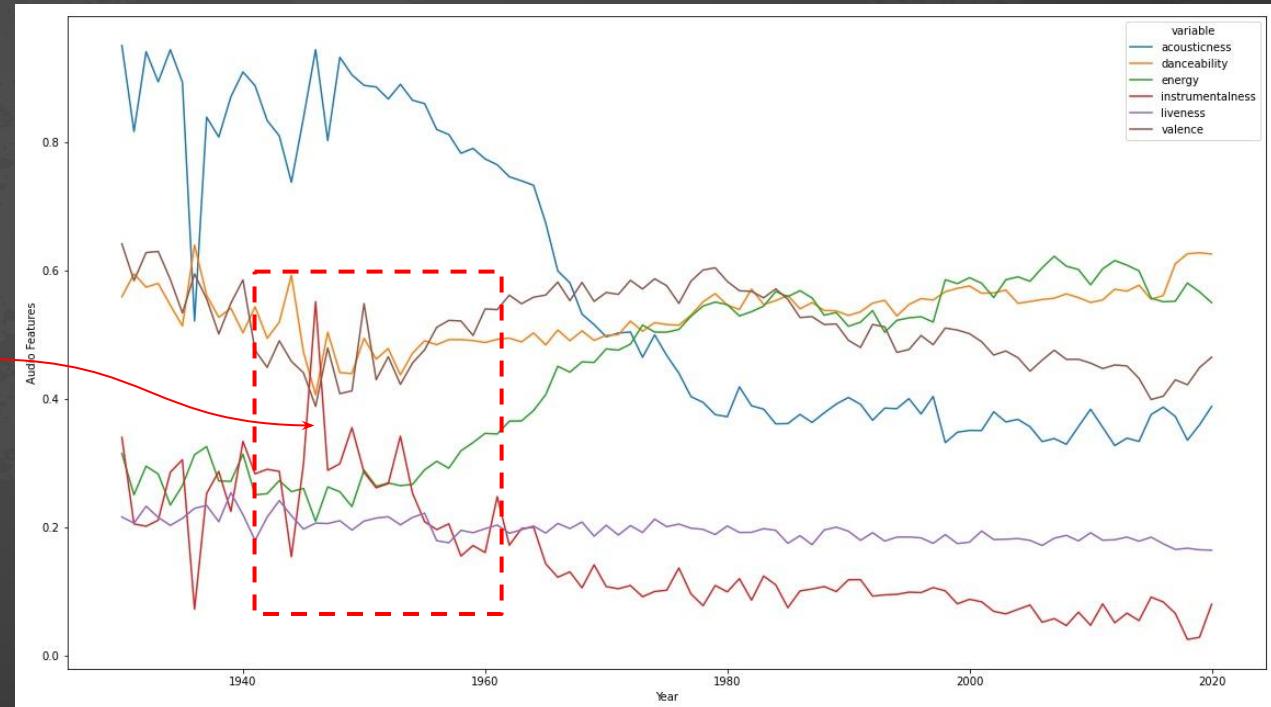
1. Sharp decline in acousticness since the introduction of synthesizers in the 1960s
2. Increasing preference for having vocals in songs since the late 1940s
3. Gradual increase in energy levels in music (i.e. Typically, energetic tracks feel fast, loud, and noisy.)



How have music tastes changed?

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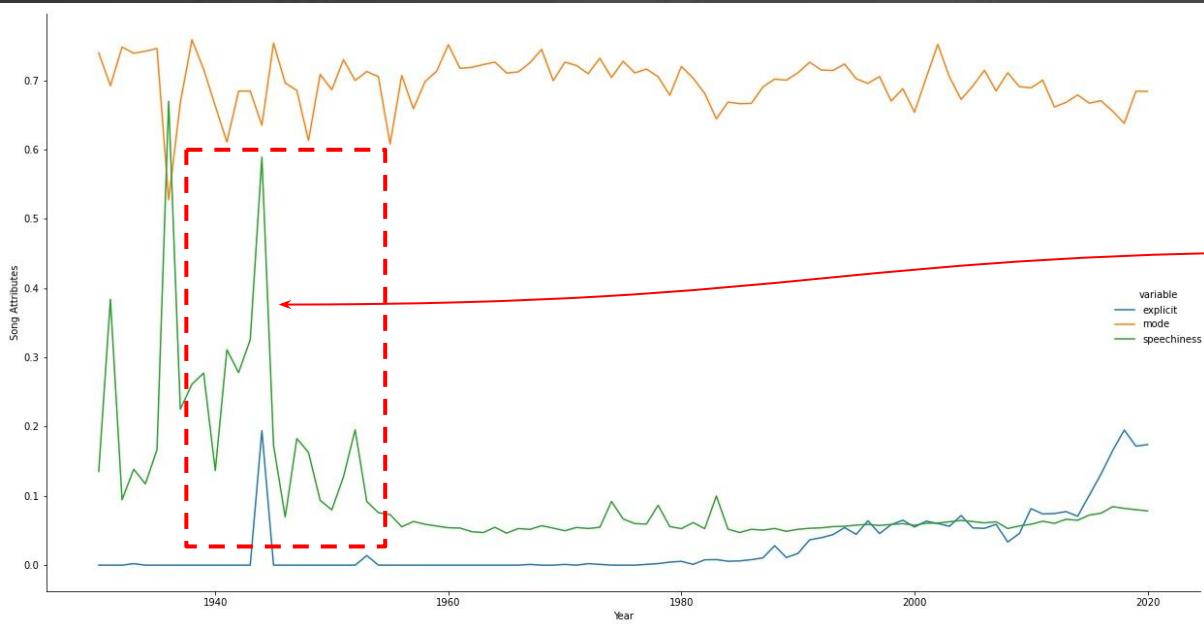
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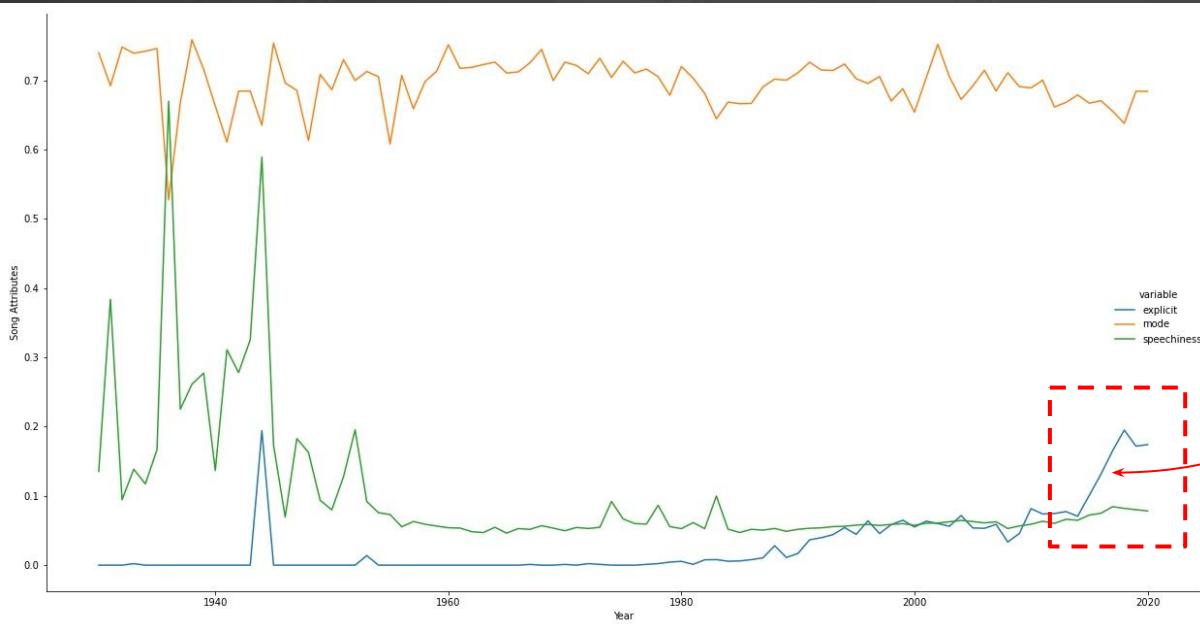
How have music tastes changed?



Insights

4. Presence of spoken words dropped sharply in the 1950s. This is likely due to the increasing preference for singing vocals in music
5. The use of explicit language has been gradually increasing

How have music tastes changed?



Insights

4. Presence of spoken words dropped sharply in the 1950s. This is likely due to the increasing preference for singing vocals in music
5. The use of explicit language has been gradually increasing

What makes a song popular?

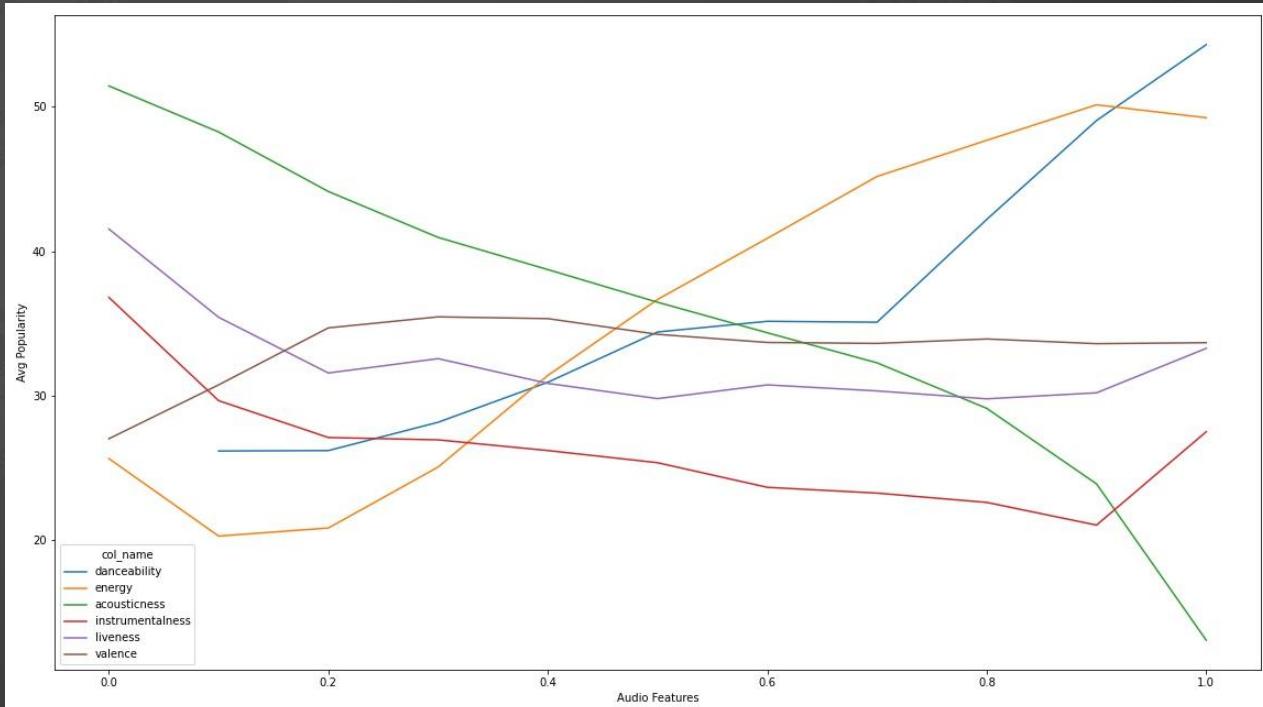
Recipe for a popular song

Dos:

- High Danceability
- High Energy

Don'ts

- High Acousticness
 - Electronic sounds preferred
- High Instrumentalness
 - Include vocals



Top artists & genres by Popularity

Artists

	artist_name	artist_genre	popularity
0	Shouse	aussietronica	88.0
1	Måneskin	indie rock italiano,italian pop	86.5
2	Justin Wellington	melanesian pop,pacific islands pop,png pop	85.0
3	Topic	dance pop,edm,electro house,german dance,pop dance,pop edm,tropical house	83.0
4	SAINt JHN	melodic rap,pop rap,rap,slap house,trap	83.0
5	SyKo	glitchcore	82.0
6	Yot Club	bedroom pop,indie pop	82.0
7	Pop Smoke	brooklyn drill	81.5
8	Pamungkas	indonesian pop	81.0
9	Vegedream	francoton,french hip hop,pop urbaine	81.0
10	Masked Wolf	australian hip hop	81.0
11	Bad Bunny	latin,reggaeton,trap latino	81.0
12	Regard	dance pop,edm,pop,pop dance,pop edm,slap house,tropical house	80.0
13	Offset	atl hip hop,hip hop,pop rap,rap,southern hip hop,trap	80.0
14	French Montana	gangster rap,hip hop,pop rap,rap,southern hip hop,trap	80.0
15	Surf Mesa	tropical house	80.0
16	Chord Overstreet	acoustic pop	80.0
17	Vedo	pop r&b,r&b	80.0
18	Ritt Momney	bedroom pop,indie pop	80.0
19	HVME	slap house	80.0

Genres

	artist_genre	popularity
0	aussietronica	88.0
1	indie rock italiano,italian pop	86.5
2	melanesian pop,pacific islands pop,png pop	85.0
3	dance pop,edm,electro house,german dance,pop dance,pop edm,tropical house	83.0
4	melodic rap,pop rap,rap,slap house,trap	83.0
5	glitchcore	82.0
6	brooklyn drill	81.5
7	francoton,french hip hop,pop urbaine	81.0
8	pop rap,sad rap	80.0
9	slap house	80.0
10	dance pop,edm,pop,pop dance,pop edm,slap house,tropical house	80.0
11	atl hip hop,hip hop,pop rap,rap,southern hip hop,trap	80.0
12	alt z,australian pop,dance pop,indie cafe pop,pop,post-teen pop,uk pop	80.0
13	dance pop,edm,pop dance,pop house,tropical house	79.5
14	latin,reggaeton,trap latino	79.3
15	australian pop,pop	79.0
16	chicago rap	79.0
17	rap,trap	79.0
18	edm,electronic trap	79.0
19	edm,electro house,pop dance,tropical house	79.0

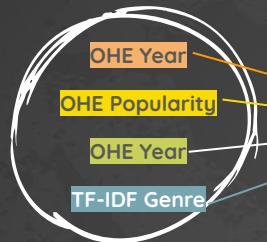
A note about Evaluation...

- With no available user data and no business metric in sight, there was no benchmark available to compare performance with.
- As a result, the only option I had was A/B testing based on attributes I felt was desirable e.g. control, variety of artists, similar sound etc
- However, In real life, this would not be the case as there will be business metrics to optimize for e.g. revenue optimization, click through rate (CTR), conversion rate.

Preprocessing & Modelling Workflow

1

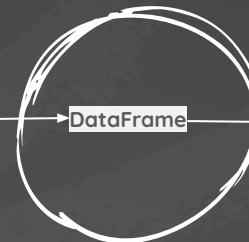
Preprocessing



Combine as a
dataframe



Cosine Similarity



Weighted Sum

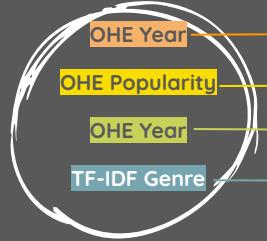


Thoughts

- Cannot be tuned
- Limited Variety in artists, year
- Decent Choices

2

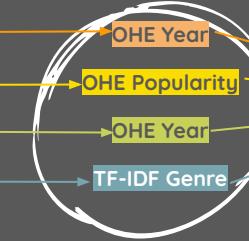
Preprocessing



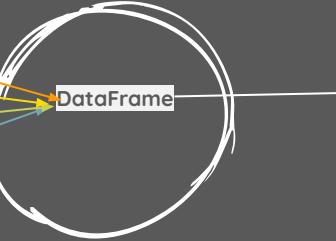
Combine as a
dataframe



Cosine Similarity



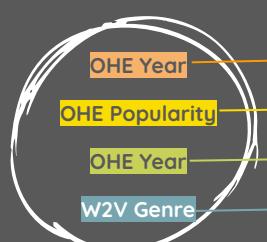
Weighted Sum



- Can be tuned,
- Limited variety in artist
- Good Choices

3

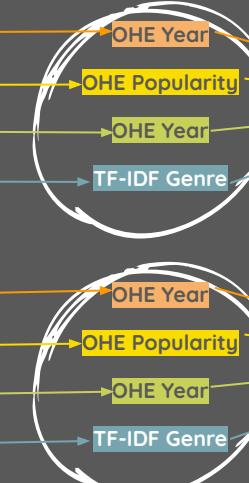
Preprocessing



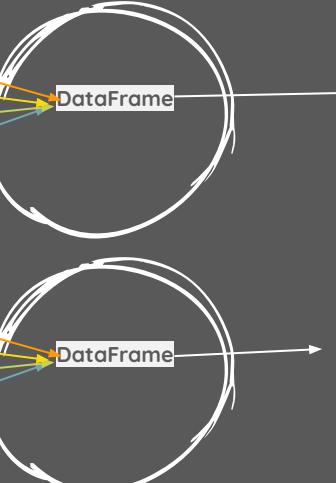
Combine as a
dataframe



Cosine Similarity



Weighted Sum



- WINNER!!**
- Bigger variety in artist, year
 - Good Choices

DEMO APP

Made possible thanks to Streamlit!!



Conclusion and Future Development

The Content-based Recommendation System did a good job recommending similar tracks.

However, there is scope for future development:

1. **Different types of data**
 - a. Historical user behavioural and user feedback data help to tailor recommendations according to user preferences
 - b. Playlist data can help train recommendation systems via song embeddings, to recognise context
2. **Different Models:**
 - a. Incorporating Deep Learning models would likely deliver better performance
3. **Deployment:**
 - a. More A/B testing will be required in order to determine the quality of the recommendations
 - b. Setup of an ML pipeline will be needed if the model is to be deployed into production



End

Thank you for your time!!!



Simple Blackboard

Here is where your presentation begins

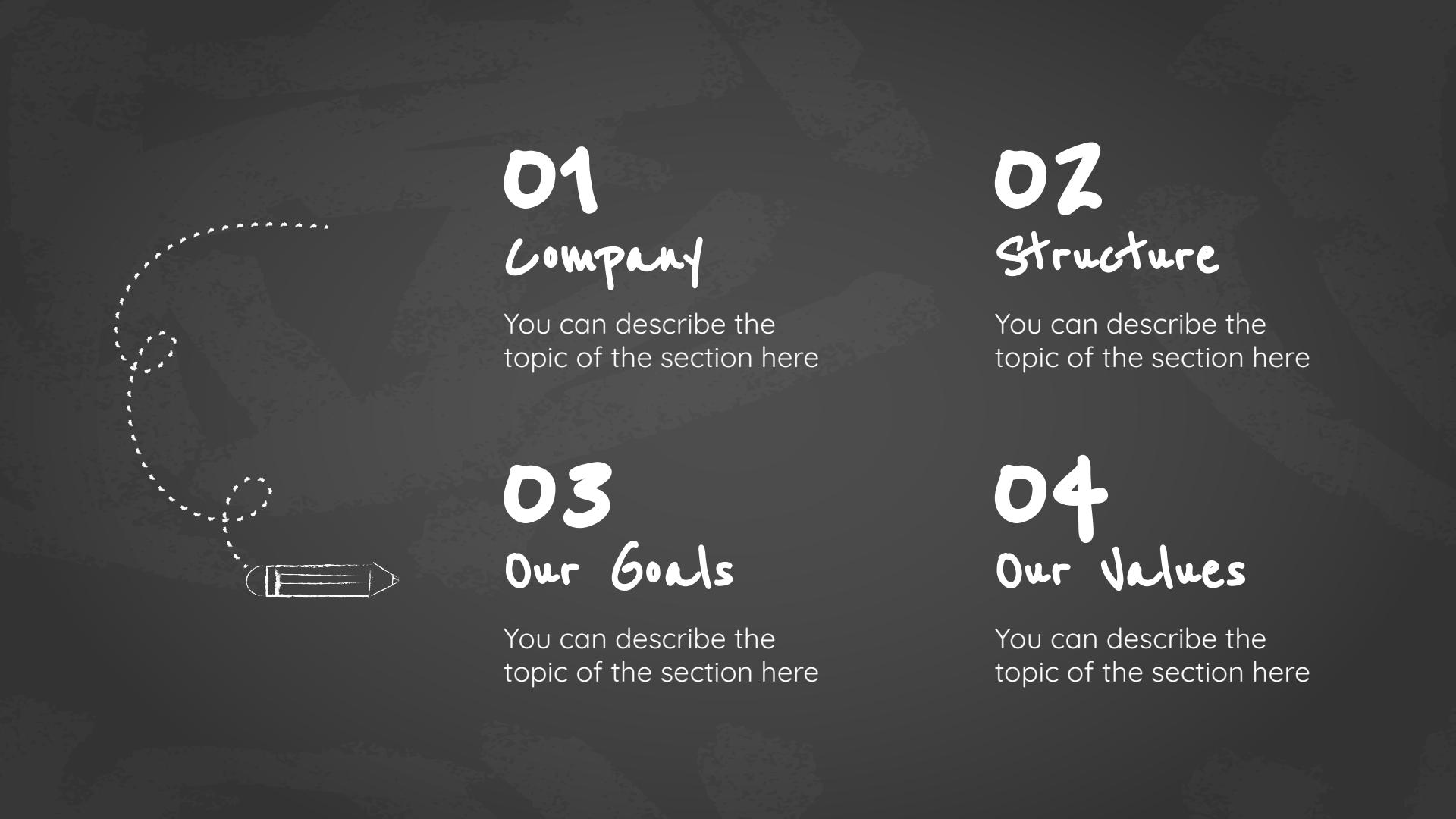


Contents of This Template

Here's what you'll find in this **Slidesgo** template:

1. A slide structure based on a **multi-purpose presentation**, which you can easily adapt to your needs. For more info on how to edit the template, please visit **Slidesgo School** or read our **FAQs**.
2. An assortment of illustrations that are suitable for use in the presentation can be found in the two **alternative resources** slides.
3. A **thanks** slide, which you must keep so that proper credits for our design are given.
4. A **resources** slide, where you'll find links to all the elements used in the template.
5. **Instructions for use.**
6. Final slides with:
 1. The **fonts and colors** used in the template.
 2. A selection of **illustrations**. You can also customize and animate them as you wish with the online editor. Visit **Storyset** to find more.
 3. More **infographic resources**, whose size and color can be edited.
 4. Sets of **customizable icons** of the following themes: general, business, avatar, creative process, education, help & support, medical, nature, performing arts, SEO & marketing, and teamwork.

You can delete this slide when you're done editing the presentation.



01 Company

You can describe the topic of the section here

02 Structure

You can describe the topic of the section here

03 Our Goals

You can describe the topic of the section here

04 Our Values

You can describe the topic of the section here



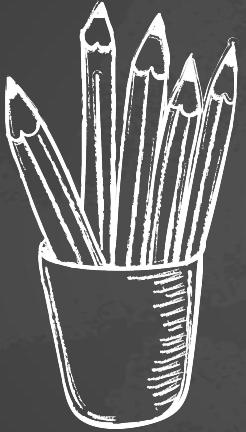
Whoa!

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



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

-Someone Famous



01

Company



You could enter a subtitle here in
case you need it

The Title Slide Goes Here!

Do you know what helps you make your point clear?

Lists like this one:

1. They're simple
2. You can organize your ideas clearly
3. You'll never forget to buy milk!

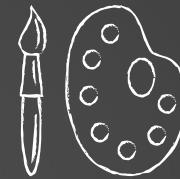
And the most important thing: the audience won't miss the point of your presentation!

You Can Divide the Content



Mercury

Mercury is the closest planet to the Sun and the smallest one in the Solar System—it's only a bit larger than the Moon



Venus

Venus has a beautiful name and is the second planet from the Sun. It's hotter than Mercury and its atmosphere is poisonous

Awesome Words

Because key words are great for catching
your audience's attention

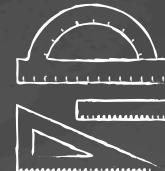


You Could Use Three Columns



Venus

Venus has a beautiful name, but is terribly hot and is also very poisonous



Saturn

This planet has several rings and is composed mostly of hydrogen and helium



Jupiter

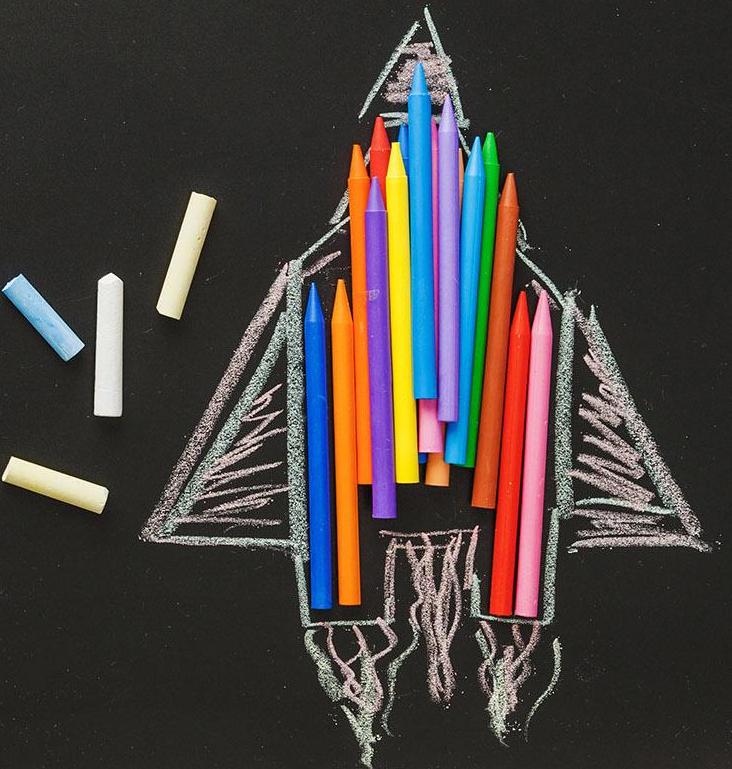
Jupiter is a gas giant and also the biggest planet in the entire Solar System



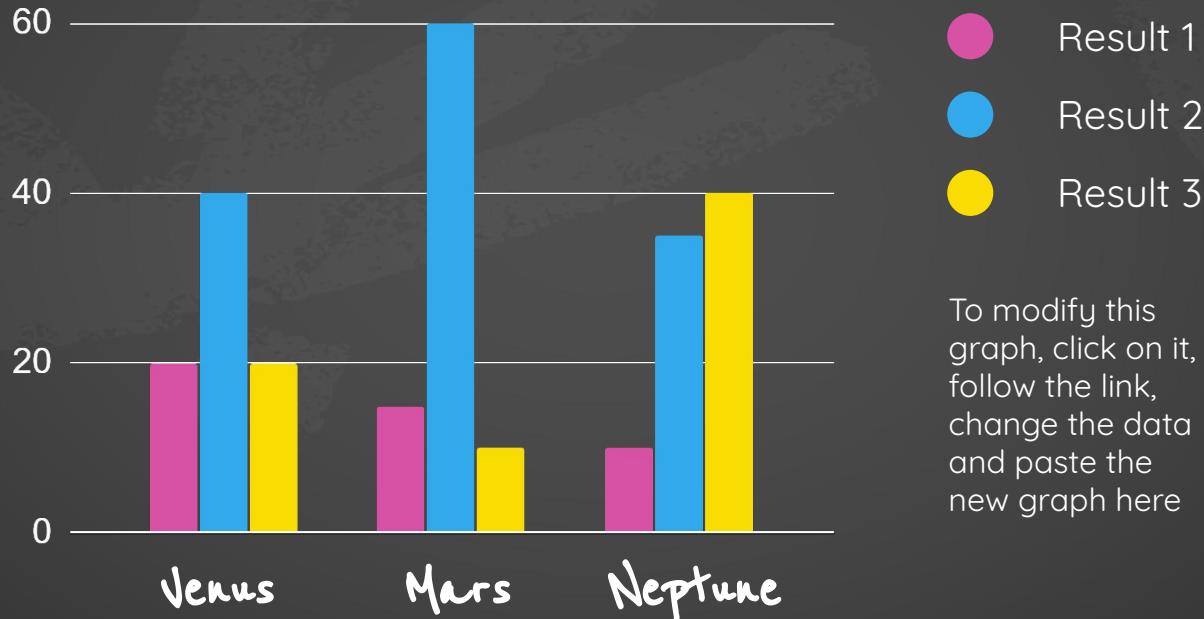
A Picture Always Reinforces the Concept

Images reveal large amounts of data, so remember: use an image instead of a long text

A Picture
Is Worth
a Thousand
Words



This Is a Graph



Reviewing Concepts: a Good Idea

Jupiter

Jupiter is the biggest planet of them all

Mercury

Mercury is the closest planet to the Sun

Saturn

It's composed of hydrogen and helium

Mars

Despite being red, Mars is a cold place

Neptune

Neptune is the farthest planet from the Sun

Venus

Venus is the second planet from the Sun

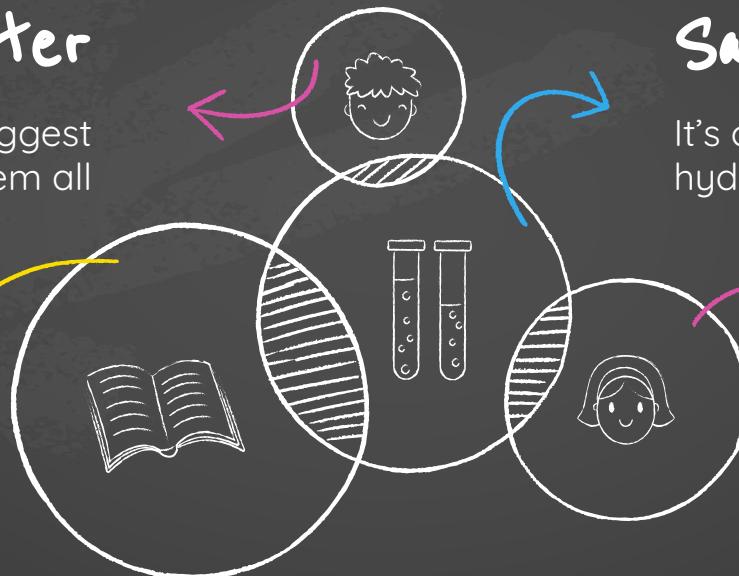
Infographics Clarify Your Ideas

Jupiter

Jupiter is the biggest planet of them all

Mars

Despite being red, Mars is a cold place



Saturn

It's composed of hydrogen and helium

Neptune

It's the farthest planet from the Sun

You Can Also Use Tables!

	Mass	Diameter	Gravity
Mercury	0.06	0.38	0.38
Mars	0.11	0.53	0.38
Saturn	95.2	9.4	1.16

This Is a Map



90%

Despite being red,
Mars is very cold

30%

Jupiter is the
biggest planet

80%

Saturn is the
ringed planet

A Timeline Works Well

01



02



03



04

Jupiter

Jupiter is the biggest planet in the Solar System

Mercury

Mercury is the closest planet to the Sun

Saturn

It's composed of hydrogen and helium

Venus

Venus has a beautiful name and is very hot



498,300,300

Big numbers catch your audience's attention





333,000

Earths is the Sun's mass



24h 37m 23s



Is Jupiter's rotation period

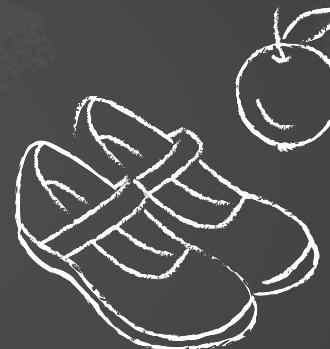


386,000 km

Distance between Earth and the Moon

OZ Structure

You could enter a subtitle here in
case you need it



Some Percentages...

30%



Despite being red, this planet is a cold place



50%



65%



90%



This is a gas giant and has several rings

Mars

Jupiter

Neptune

Saturn

Two More Columns!



Saturn

Yes, this is the ringed one. It's a gas giant, composed mostly of hydrogen and helium



Neptune

Neptune is the farthest planet from the Sun and the fourth-largest in the Solar System



Four Columns to Divide the Info

Saturn

This gas giant is composed mostly of hydrogen and also helium



Neptune

Neptune is the farthest planet from the Sun and the fourth-largest by diameter

Mars

Despite being red, Mars is actually a cold place full of iron oxide dust



Jupiter

Jupiter is a gas giant and the biggest planet in the Solar System

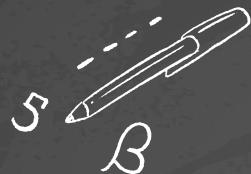
This Is an Exercise

Mercury

Mercury is the closest planet to the Sun and the smallest one in the Solar System—it's only a bit larger than the Moon



This Is an Assignment



Neptune?

Is Neptune the
farthest planet from
the Sun?

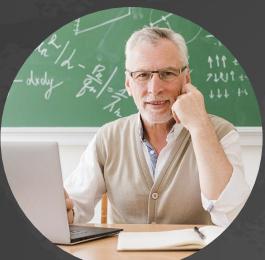
Mars?

Despite being red, is
Mars actually a very
cold place?

Venus?

Does Venus really
have a poisonous
atmosphere?

Our Team



Samuel

You can replace the image on the screen with your own



Helena

You can replace the image on the screen with your own

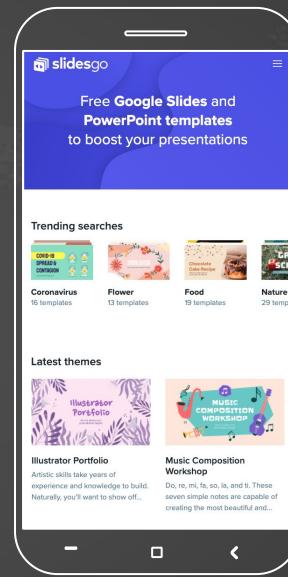


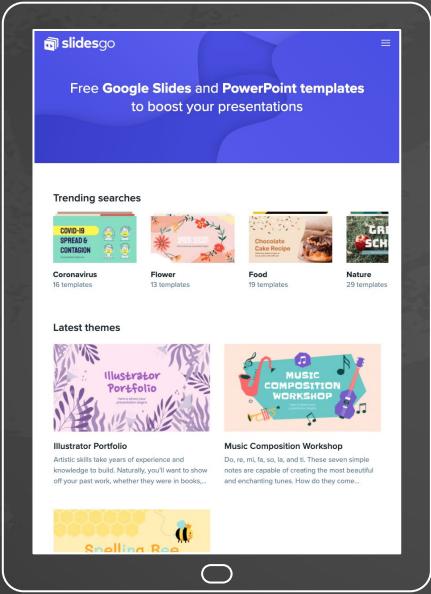
Martha

You can replace the image on the screen with your own

Mobile App

You can replace the image on the screen with your own work. Just delete this one, add yours and center it properly



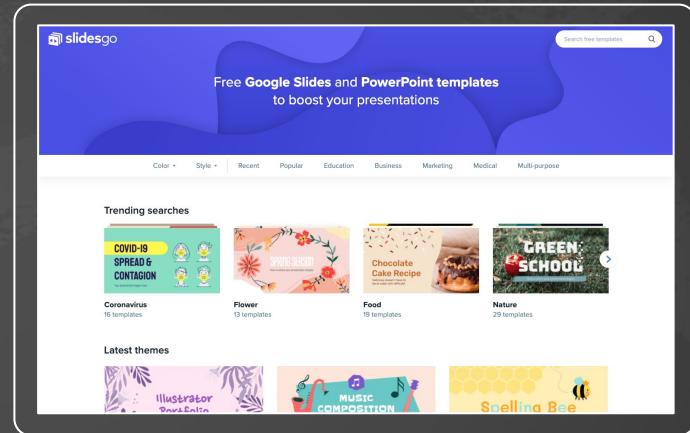


Tablet Website

You can replace the image on the screen with your own work. Just delete this one, add yours and center it properly

Desktop Software

You can replace the image on the screen with your own work. Just delete this one, add yours and center it properly



Thanks!

Do you have any questions?

youremail@freepik.com

+91 620 421 838

yourcompany.com

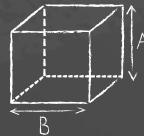
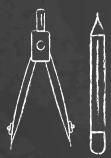


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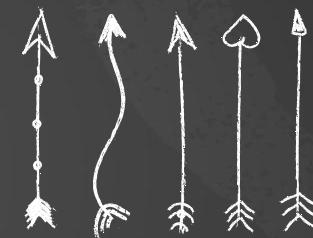
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Alternative Resources



$$E=mc^2$$
$$\sqrt{25}$$



Resources

VECTORS:

- Arrow collection in chalk style
- School background with blackboard style
- Creative school elements blackboard style
- Ribbons, frames and arrows blackboard style
- Set of ribbons and arrows blackboard style
- Set school elements chalkboard style
- Set school elements chalkboard style 2
- Chalk lines with different colors
- Circle hand drawn infographic
- Blackboard back to school background
- Blackboard back to school background 2
- Blackboard back to school background
- Different school elements in chalkboard style
- Realistic math chalkboard background
- Infographic elements set in blackboard style
- Hand drawn variety of infographic elements

PHOTOS:

- Plane made with chalk
- Pupil girl with chalk bulb
- Teacher sitting at desk
- Smiling teacher near laptop
- Smiling girl holding notebooks
- Blackboard slate with colourful stationery
- Smiling girl with notepad in class
- Teacher in class with clipboard
- Smiley teacher at her desk in classroom
- Girl student with notepad

ICONS:

- Back to school icon pack premium

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Reenie Beanie

(<https://fonts.google.com/specimen/Reenie+Beanie>)

Quicksand

(<https://fonts.google.com/specimen/Quicksand>)

#d752a4

#31a9ea

#f9dc01

#595959

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

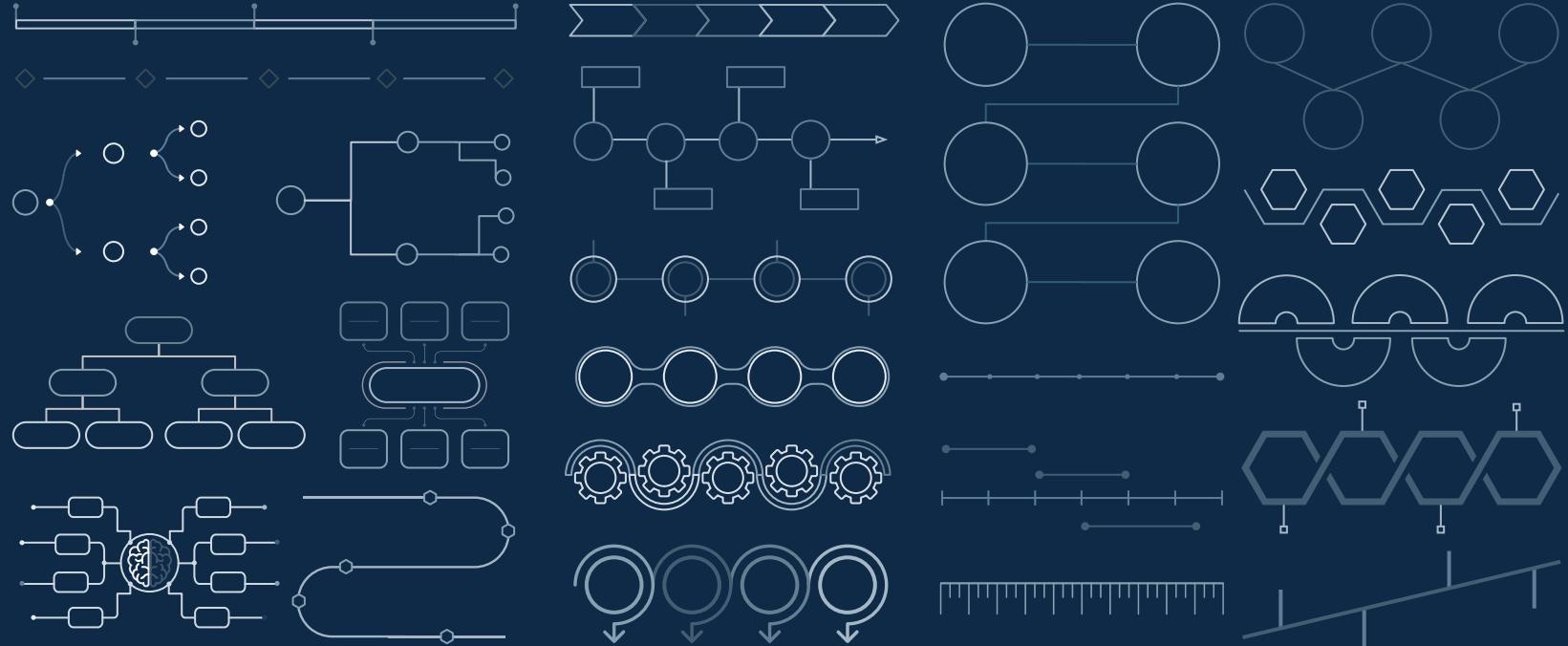
Use our editable graphic resources...

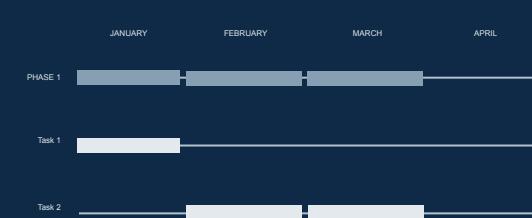
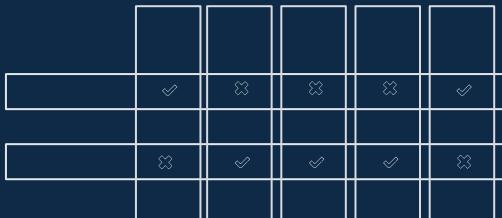
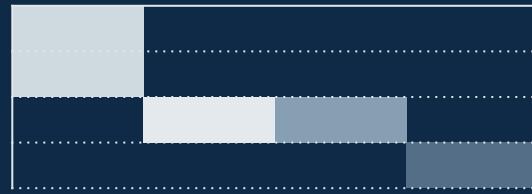
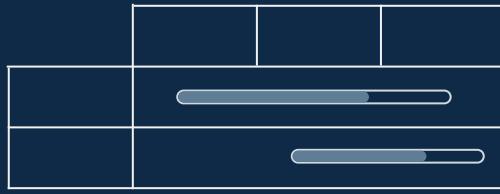
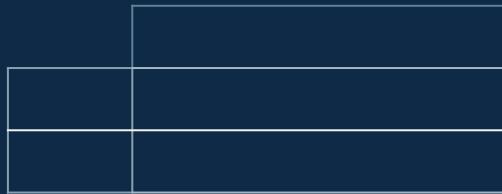
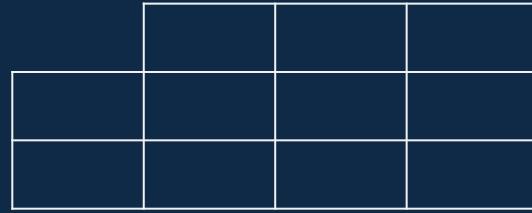
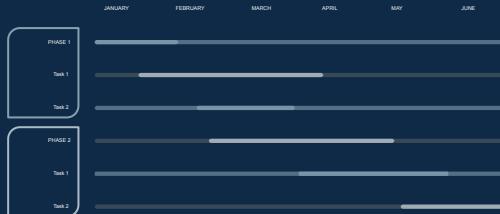
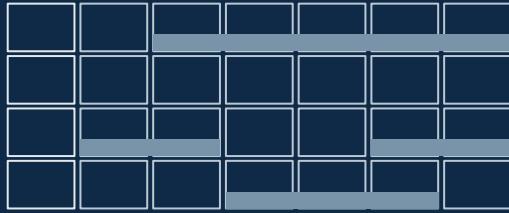
You can easily resize these resources without losing quality. To change the color, just ungroup the resource and click on the object you want to change. Then, click on the paint bucket and select the color you want.

Group the resource again when you're done. You can also look for more infographics on Slidesgo.

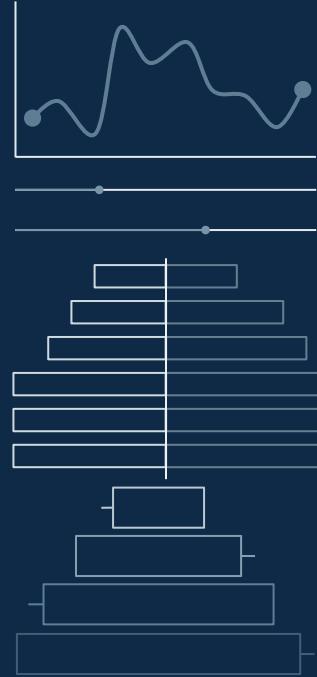
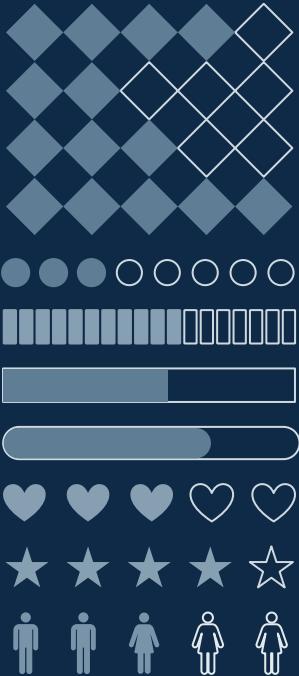
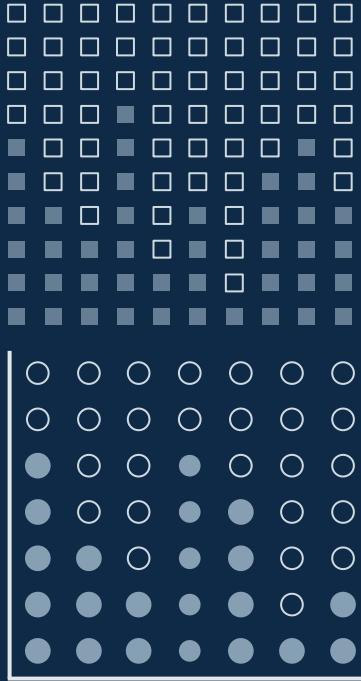












...and our sets of editable icons

You can resize these icons without losing quality.

You can change the stroke and fill color; just select the icon and click on the paint bucket/pen.

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



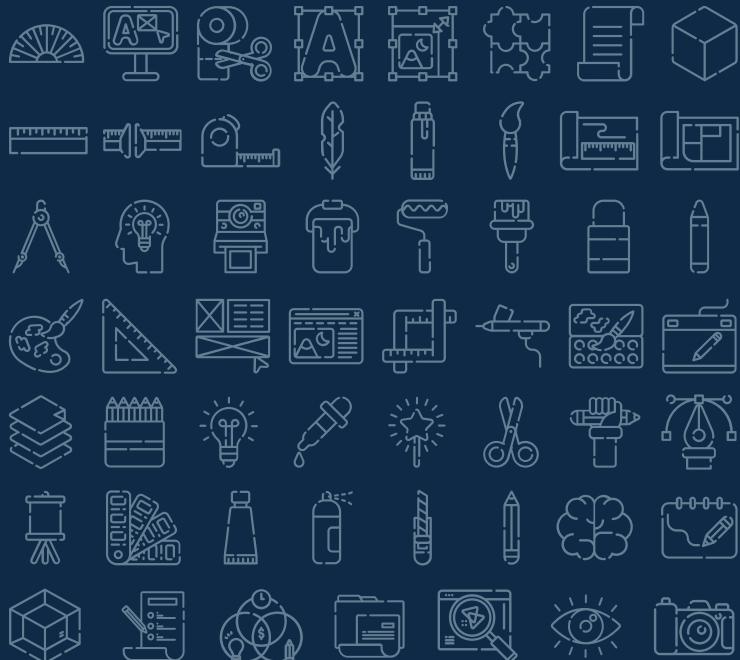
Help & Support Icons



Avatar Icons



Creative Process Icons



Performing Arts Icons



Nature Icons



SEO & Marketing Icons



