



# K-Dimensional Trees

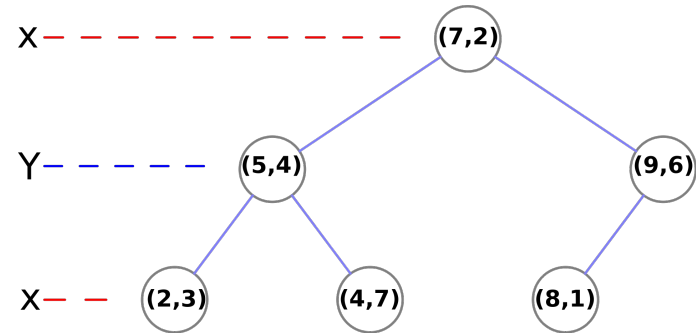
André Flores, up201907001

Diogo Faria, up201907014

Tiago Rodrigues, up201906807

# What is a K-Dimensional Tree?

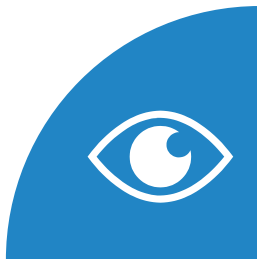
- ▷ A space-partitioning data structure.
- ▷ Special case of binary space partitioning trees where the partitions are axis-aligned.
- ▷ Searched using a k-dimensional key.
- ▷ Every node is usually a k-dimensional point.
- ▷ Every level of the tree discriminates 1 dimension, the  $(L \bmod k)$ th dimension.



# General Uses

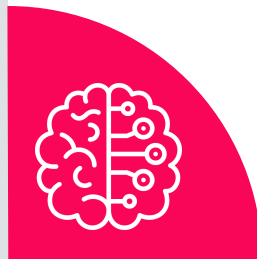
## Computer Vision

Feature Matching  
Object Recognition



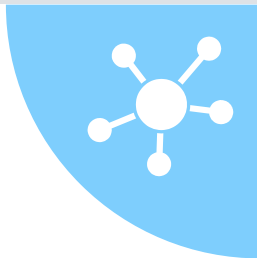
## Machine Learning

k-Nearest Neighbours  
classification  
Anomaly Detection



Dynamic systems with n-bodies  
Fields of astrophysics, molecular  
dynamics and fluid dynamics

## Simulation



Search engines in general  
Text and Image search engines

## Search Engines



# Our idea

- ▷ Recommendation system that would be based on the characteristics of a song, creating a playlist of similar ones.
- ▷ Each song has certain attributes like acousticness, energy, liveness, etc.
- ▷ Each of these attributes can be used as a dimension for a K-d tree.
- ▷ We can then search for each song's nearest neighbours in order to find similar songs.

# Why we've chosen this?

## Efficiency

KD Trees are efficient for algorithms such as Nearest Neighbour and Clustering

## Data

We have a lot of data to use (8.74 million tracks) straight from Spotify, which ensures its quality.

## Accessibility

This product allows us to focus on the trees as opposed to others like ray-tracing that need a heavy graphical component

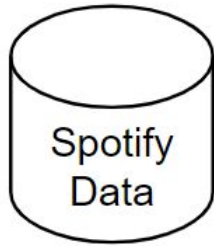
# Functionalities

- ▷ User should be able to create a playlist based on a particular song.
- ▷ User should be able to search for a song, to be able to select it later.
- ▷ User should be able to customize playlist creation:
  - Select values for liveliness, energy, danceability, etc.
  - Select artists
  - Select genre

# Technologies

kaggle

 python™



Data Processing

Implementation

# Data

id	acousticness	analysis_url	danceability	duration	energy	instrumentalness
2jKoVlU7VAmExKJ1Jh3w9P	0.180000007152557	<a href="https://api.spotify.com/v1/audio-analysis/2jKoVlU7VAmExKJ1Jh3w9P">https://api.spotify.com/v1/audio-analysis/2jKoVlU7VAmExKJ1Jh3w9P</a>	0.89300000667572	219160	0.513999998569489	0.0
4JYUDRtPZuVNi7FAnbHyux	0.272000014781952	<a href="https://api.spotify.com/v1/audio-analysis/4JYUDRtPZuVNi7FAnbHyux">https://api.spotify.com/v1/audio-analysis/4JYUDRtPZuVNi7FAnbHyux</a>	0.519999980926514	302013	0.847000002861023	0.0
6YjKAKdYmIasMqYw73iB0w	0.0782999992370605	<a href="https://api.spotify.com/v1/audio-analysis/6YjKAKdYmIasMqYw73iB0w">https://api.spotify.com/v1/audio-analysis/6YjKAKdYmIasMqYw73iB0w</a>	0.917999982833862	288200	0.586000025272369	0.0
2YlvHjDb4Tyx14A1IcDhAe	0.583999991416931	<a href="https://api.spotify.com/v1/audio-analysis/2YlvHjDb4Tyx14A1IcDhAe">https://api.spotify.com/v1/audio-analysis/2YlvHjDb4Tyx14A1IcDhAe</a>	0.876999974250793	243013	0.680999994277954	0.0
3U0uBNEin5peSRqdzvlnWM	0.170000001788139	<a href="https://api.spotify.com/v1/audio-analysis/3U0uBNEin5peSRqdzvlnWM">https://api.spotify.com/v1/audio-analysis/3U0uBNEin5peSRqdzvlnWM</a>	0.814000010490417	270667	0.781000018119812	0.0005179999861866
2g8HN35AnVGIk7B8yMucww	0.430000007152557	<a href="https://api.spotify.com/v1/audio-analysis/2g8HN35AnVGIk7B8yMucww">https://api.spotify.com/v1/audio-analysis/2g8HN35AnVGIk7B8yMucww</a>	0.779999971389771	252747	0.574999988079071	0.0



# Implementation

- ▷ A K-dimensional tree with 11 dimensions:
  - acousticness, danceability, energy, instrumentalness, liveness, loudness, mode, speechiness, tempo, time signature, and valence.
- ▷ Other information, such as: name, artist, etc, would be kept on the node.

# Construction

- ▷ To speed up the construction, we will use the following methods:
  - We'll use random subsets to determine medians, which does not guarantee but still often leads to balanced trees.
  - We'll make use of parallelism when constructing the branches of the tree, giving our implementation very strong scalability.

# Algorithms

## **K-Nearest Neighbour**

$O(m * \log n)$  complexity in a balanced k-d tree, with  $m$  being the number of nodes to be found.

## **Range Search**

Usually  $O(\sqrt{n} + k)$  on a balanced tree, with  $k$  being the number of dimensions in the tree.

# Benchmarking

## Execution time

Note how objectively fast it is and compare with Tunebat, a website that uses the same characteristics we'll use to find similar songs.

## Results quality

Compare results with several platforms, such as Spotify itself, that provide recommendations.

## Scalability

We want to evaluate how well our implementation scales across multiple threads.

Thanks!

**Any questions?**

What is K-DIMENSION trees? Pequeno resumo para nao ser entediante

- > Usos gerais
- > Uso especificado (razão)
- > O que esperamos implementar para o mvp
  - > Funcionalidades
  - > Letter of intent
- > Tecnologias a usar
- > Especificação da nossa implementação
- > Real data para stress test para o mvp

# Instructions for use

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# Hello!

## I am Jayden Smith

I am here because I love to give presentations.

You can find me at:

@username





1.

# TRANSITION HEADLINE

Let's start with the first set of slides



*Quotations are commonly printed as a means of inspiration and to invoke philosophical thoughts from the reader.*

# This is a slide title

- ▷ Here you have a list of items
- ▷ And some text
- ▷ But remember not to overload your slides with content

Your audience will listen to you or read the content, but won't do both.



# Big concept

Bring the attention of your audience over a key concept using icons or illustrations

# You can also split your content

## **White**

Is the color of milk and fresh snow, the color produced by the combination of all the colors of the visible spectrum.

## **Black**

Is the color of ebony and of outer space. It has been the symbolic color of elegance, solemnity and authority.

# In two or three columns

## **Yellow**

Is the color of gold, butter and ripe lemons. In the spectrum of visible light, yellow is found between green and orange.

## **Blue**

Is the colour of the clear sky and the deep sea. It is located between violet and green on the optical spectrum.

## **Red**

Is the color of blood, and because of this it has historically been associated with sacrifice, danger and courage.

A picture is worth a thousand words

A complex idea can be conveyed with just a single still image, namely making it possible to absorb large amounts of data quickly.

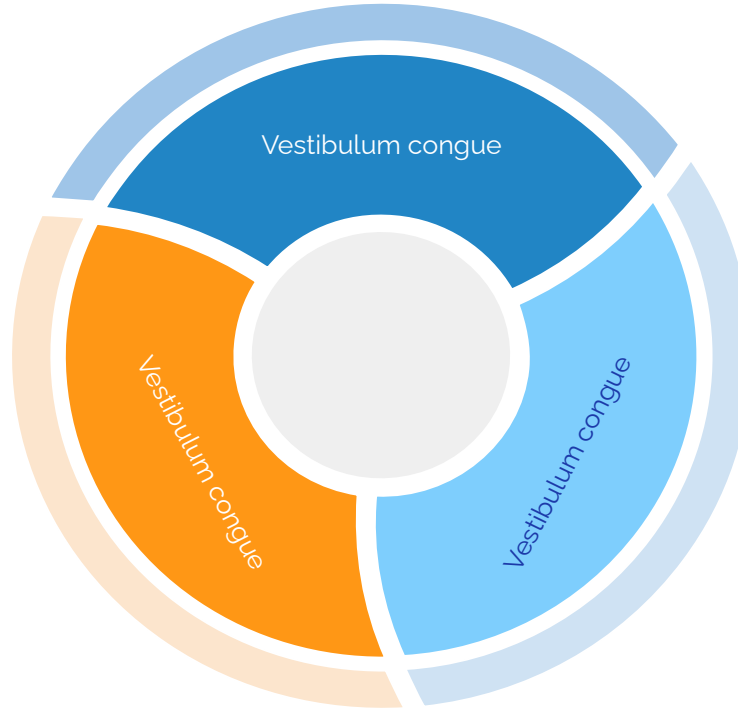




Want big impact?  
Use big image.



# Use diagrams to explain your ideas



# And tables to compare data

	A	B	C
Yellow	10	20	7
Blue	30	15	10
Orange	5	24	16

# Maps





89,526,124

Whoa! That's a big number, aren't you proud?



89,526,124\$

That's a lot of money



185,244 users

And a lot of users



100%

Total success!

# Our process is easy

First

Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit.

Second

Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit.

Last

Lorem ipsum dolor sit  
amet, consectetur  
adipiscing elit.

# Let's review some concepts



## Yellow

Is the color of gold, butter and ripe lemons. In the spectrum of visible light, yellow is found between green and orange.



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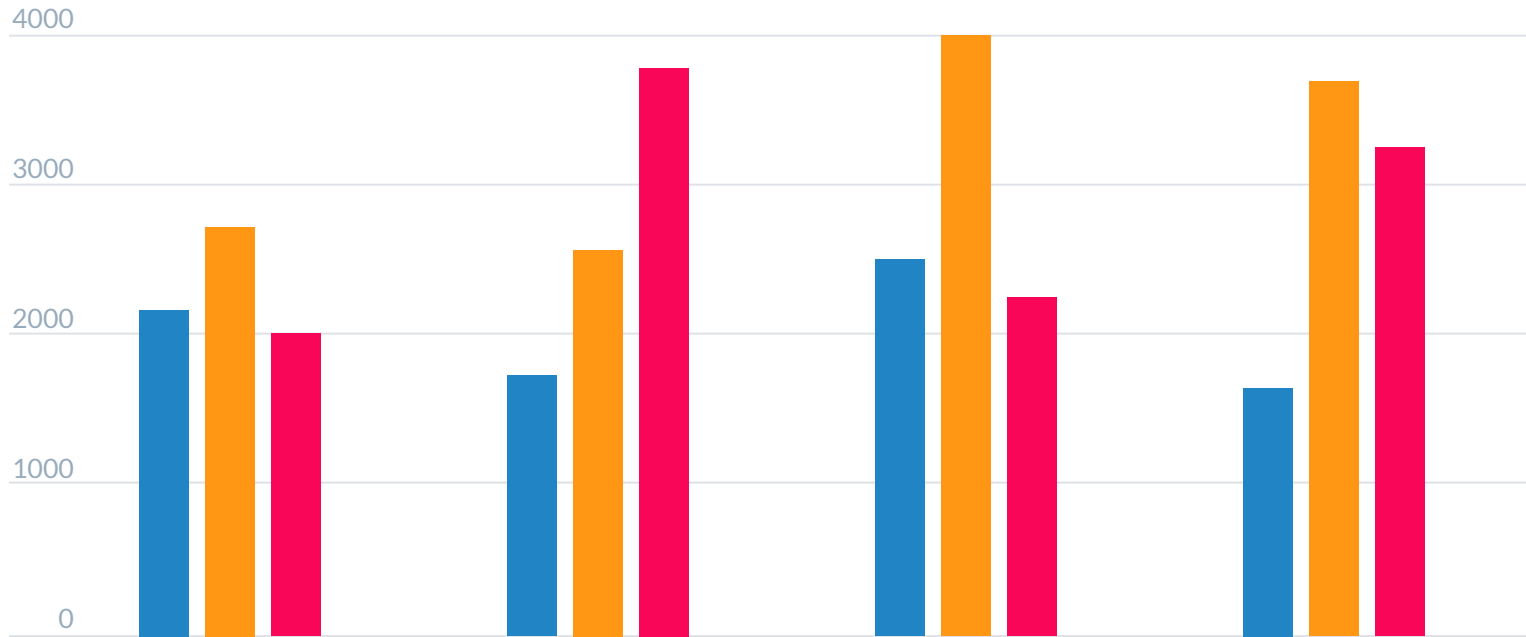
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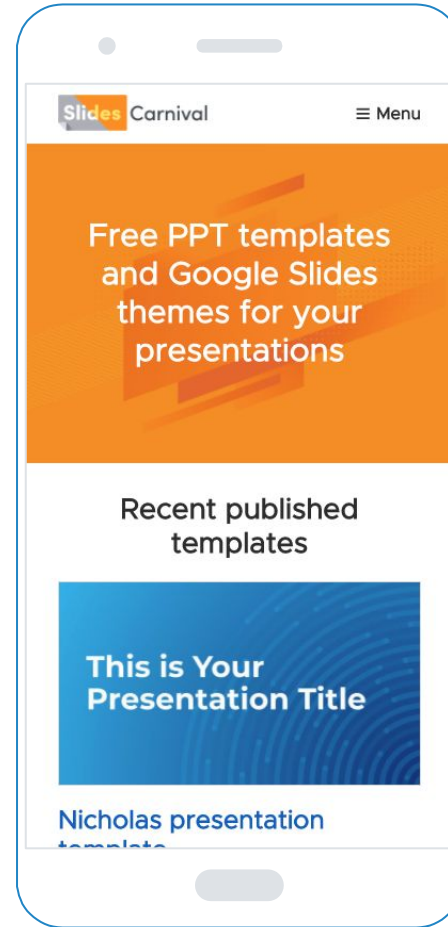


You can copy&paste graphs from Excel & Google Sheets



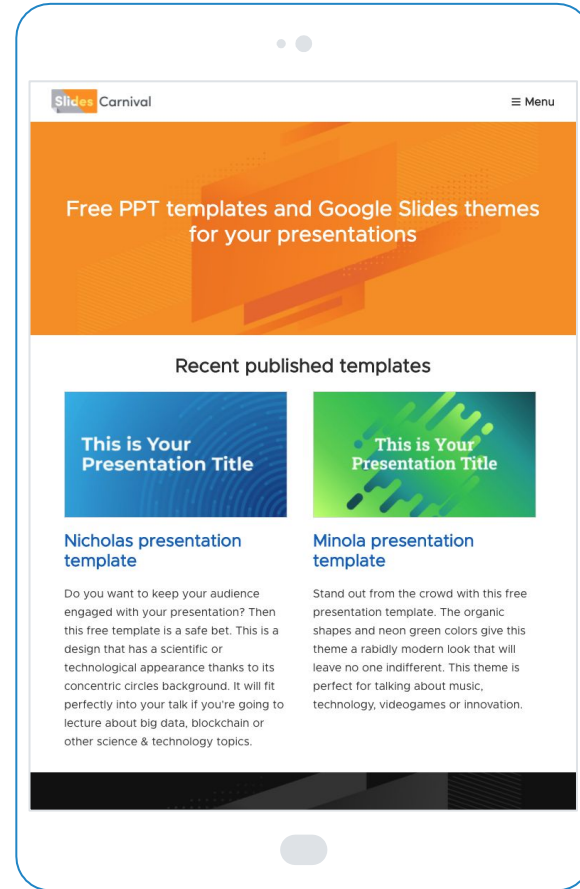
Mobile project

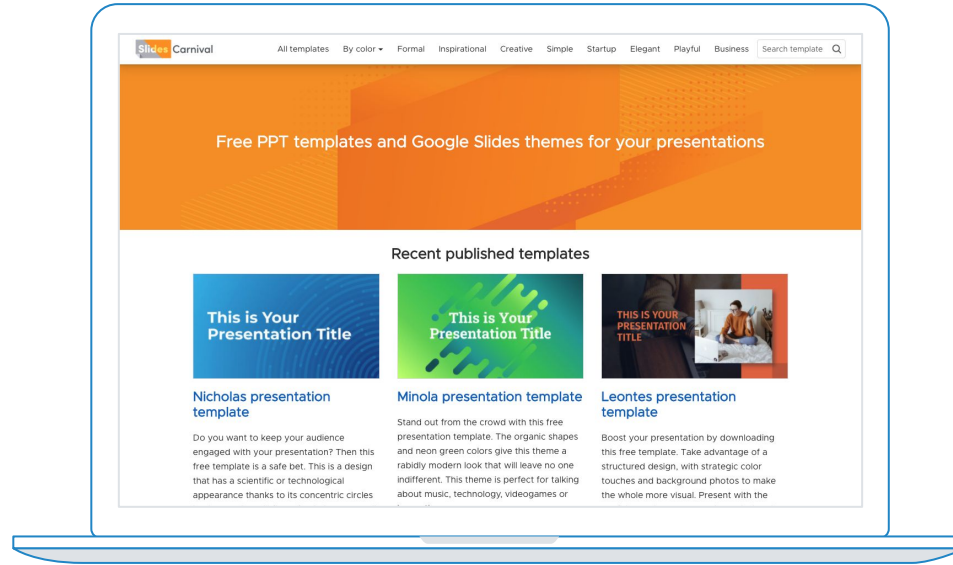
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## Tablet project

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## Desktop project

# Show and explain your web, app or software projects using these gadget templates.

# Thanks!

## Any questions?

You can find me at:

@username

user@mail.me

# Credits

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- ▷ Presentation template by SlidesCarnival
- ▷ Photographs by Unsplash

# Presentation design

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- ▷ Titles: **Raleway**
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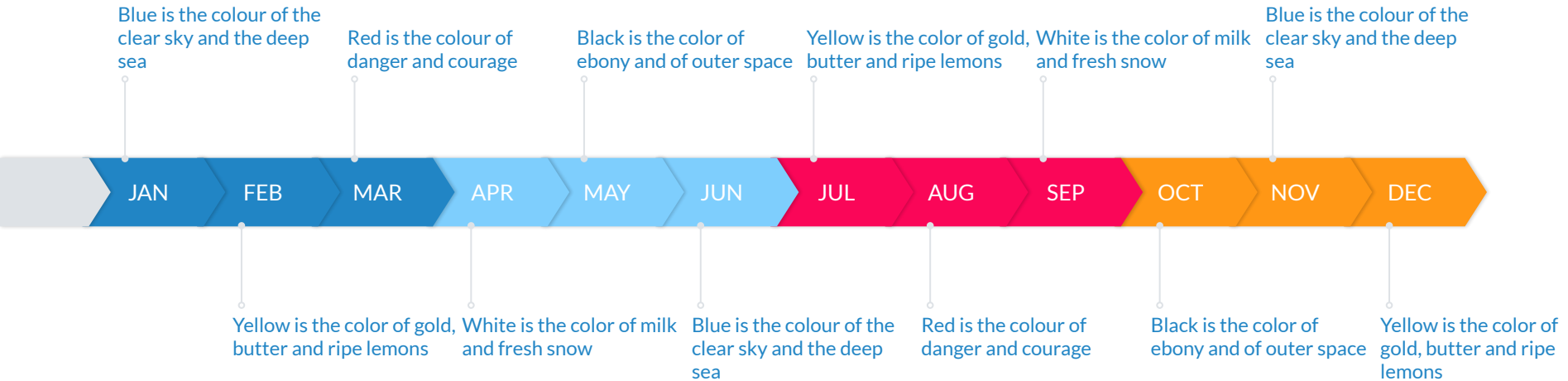
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2.

# EXTRA RESOURCES

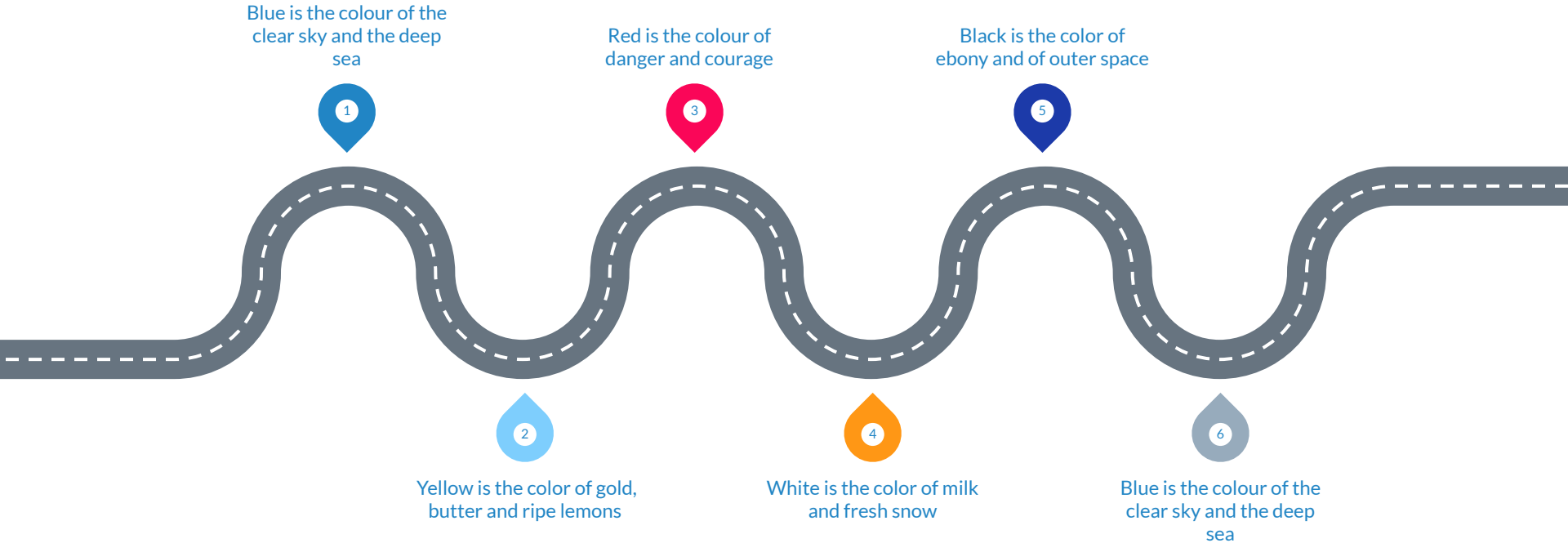
For Business Plans, Marketing Plans, Project Proposals,  
Lessons, etc

# Timeline

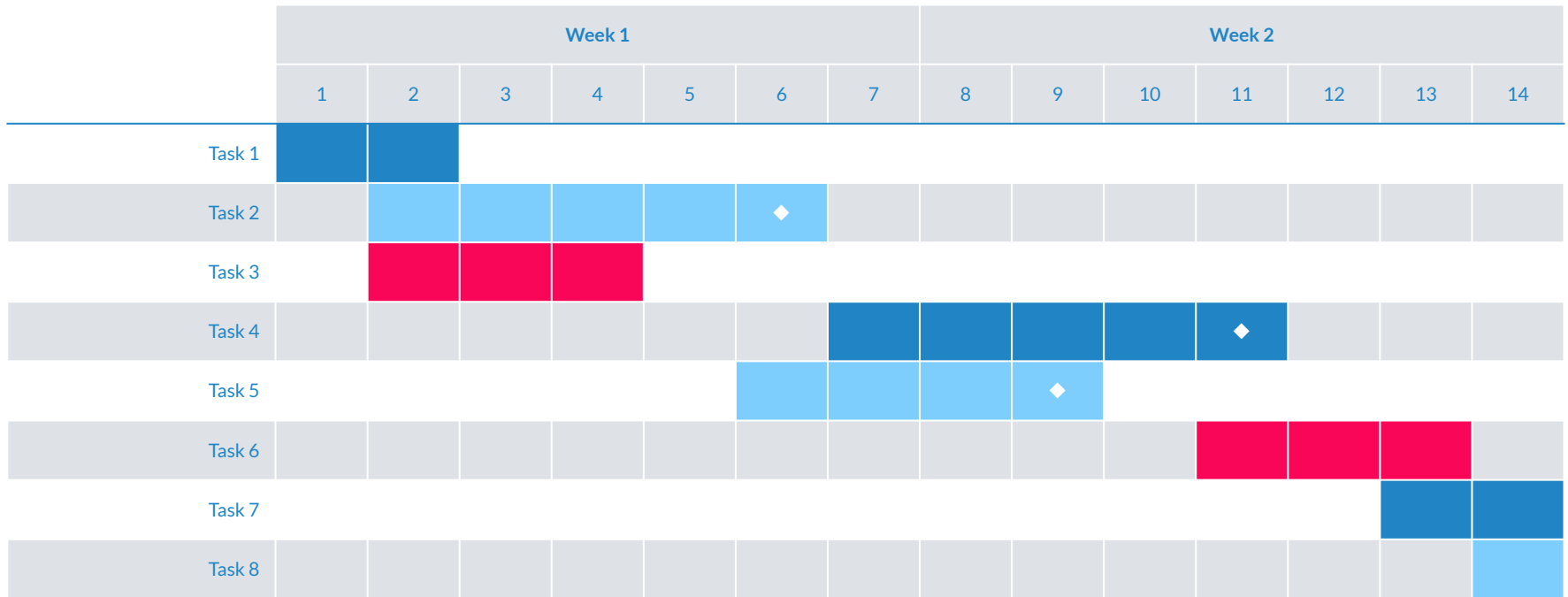




# Roadmap



# Gantt chart



# SWOT Analysis

## STRENGTHS

Blue is the colour of the clear sky  
and the deep sea

S

## WEAKNESSES

Yellow is the color of gold, butter  
and ripe lemons

W

Black is the color of ebony and of  
outer space

## OPPORTUNITIES










O

White is the color of milk and fresh  
snow

## THREATS

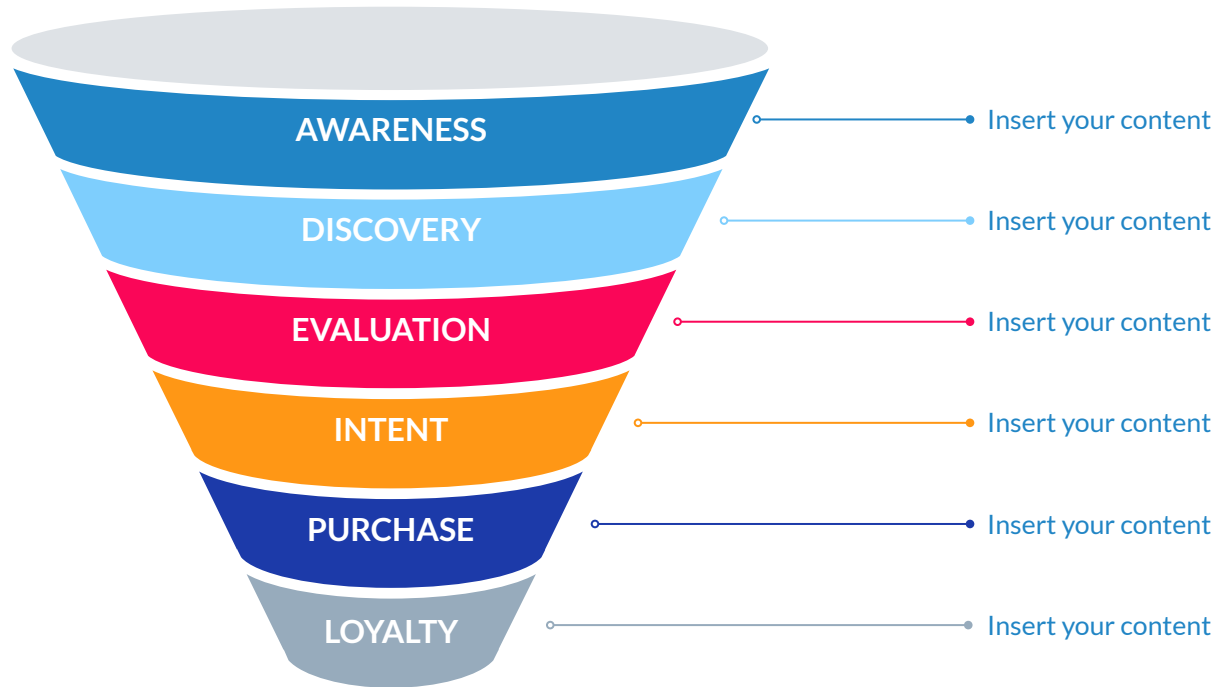
T

Business Model Canvas

<div>Key Partners</div> <div>Insert your content</div> <div></div>	<div>Key Activities</div> <div>Insert your content</div> <div></div>	<div>Value Propositions</div> <div>Insert your content</div> <div></div>	<div>Customer Relationships</div> <div>Insert your content</div> <div></div>	<div>Customer Segments</div> <div>Insert your content</div> <div></div>
	<div>Key Resources</div> <div>Insert your content</div> <div></div>		<div>Channels</div> <div>Insert your content</div> <div></div>	
<div>Cost Structure</div> <div>Insert your content</div> <div></div>			<div>Revenue Streams</div> <div>Insert your content</div> <div></div>	



# Funnel



# Team Presentation



**Imani Jackson**

JOB TITLE

Blue is the colour of the clear  
sky and the deep sea



**Marcos Galán**

JOB TITLE

Blue is the colour of the clear  
sky and the deep sea



**Ixchel Valdía**

JOB TITLE

Blue is the colour of the clear  
sky and the deep sea

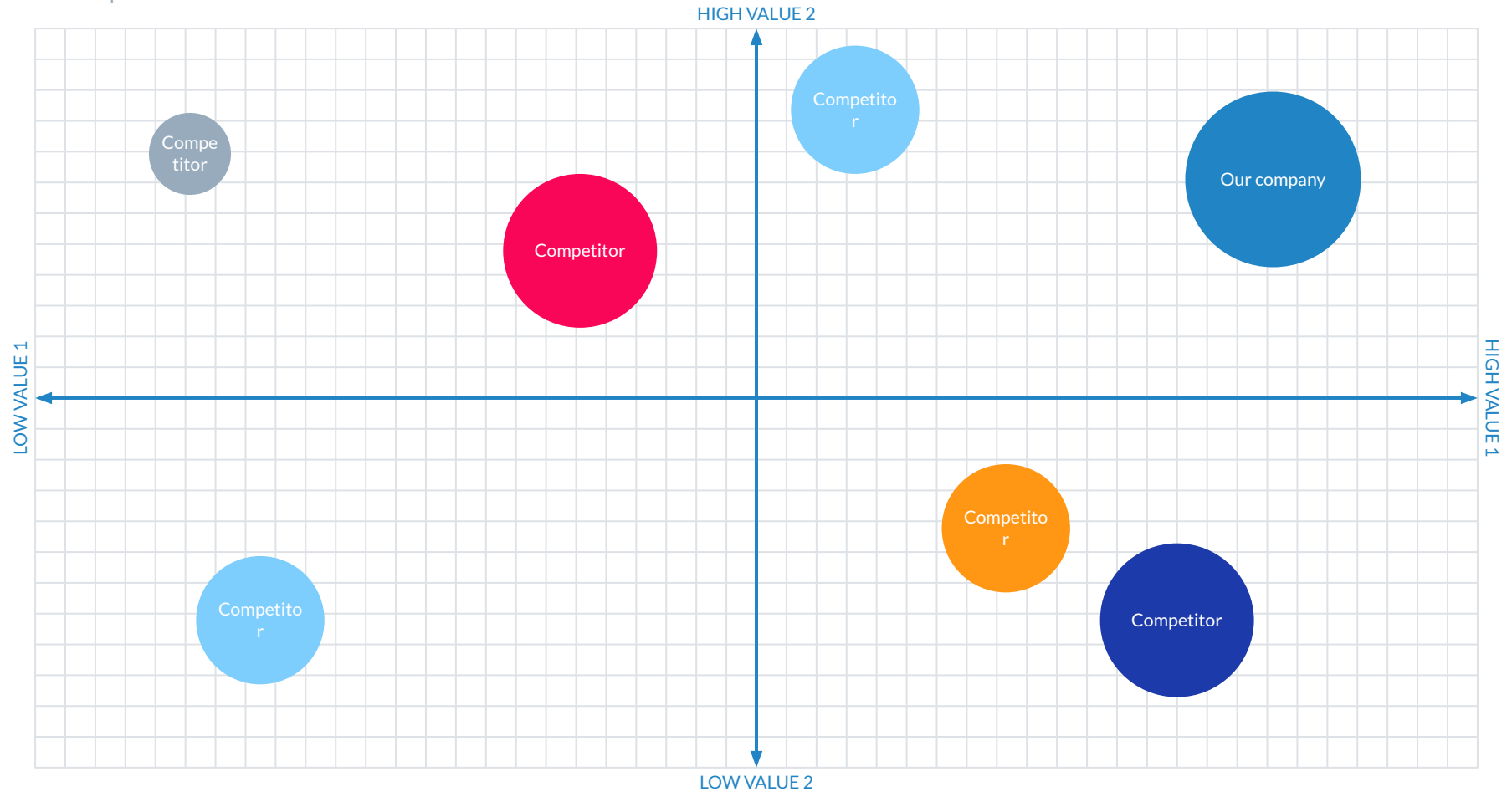


**Nils Årud**

JOB TITLE

Blue is the colour of the clear  
sky and the deep sea

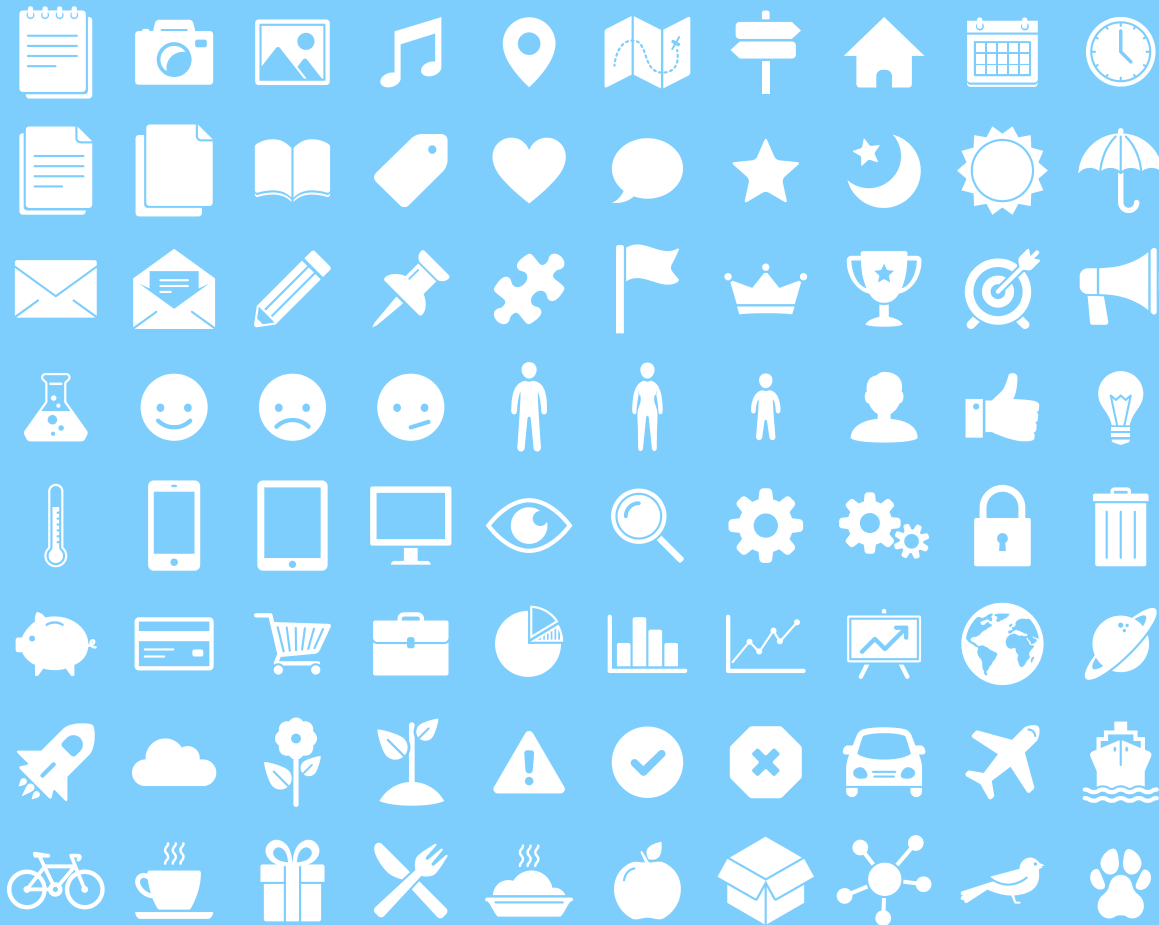
# Competitor Matrix



# Weekly Planner

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
09:00 - 09:45	Task	Task	Task	Task	Task	Task	Task
10:00 - 10:45	Task	Task	Task	Task	Task	Task	Task
11:00 - 11:45	Task	Task	Task	Task	Task	Task	Task
12:00 - 13:15	✓ Free time	✓ Free time	✓ Free time	✓ Free time	✓ Free time	✓ Free time	✓ Free time
13:30 - 14:15	Task	Task	Task	Task	Task	Task	Task
14:30 - 15:15	Task	Task	Task	Task	Task	Task	Task
15:30 - 16:15	Task	Task	Task	Task	Task	Task	Task





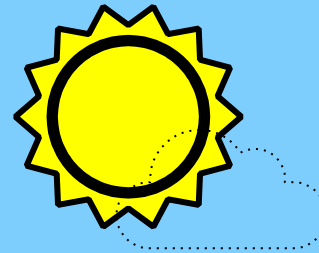
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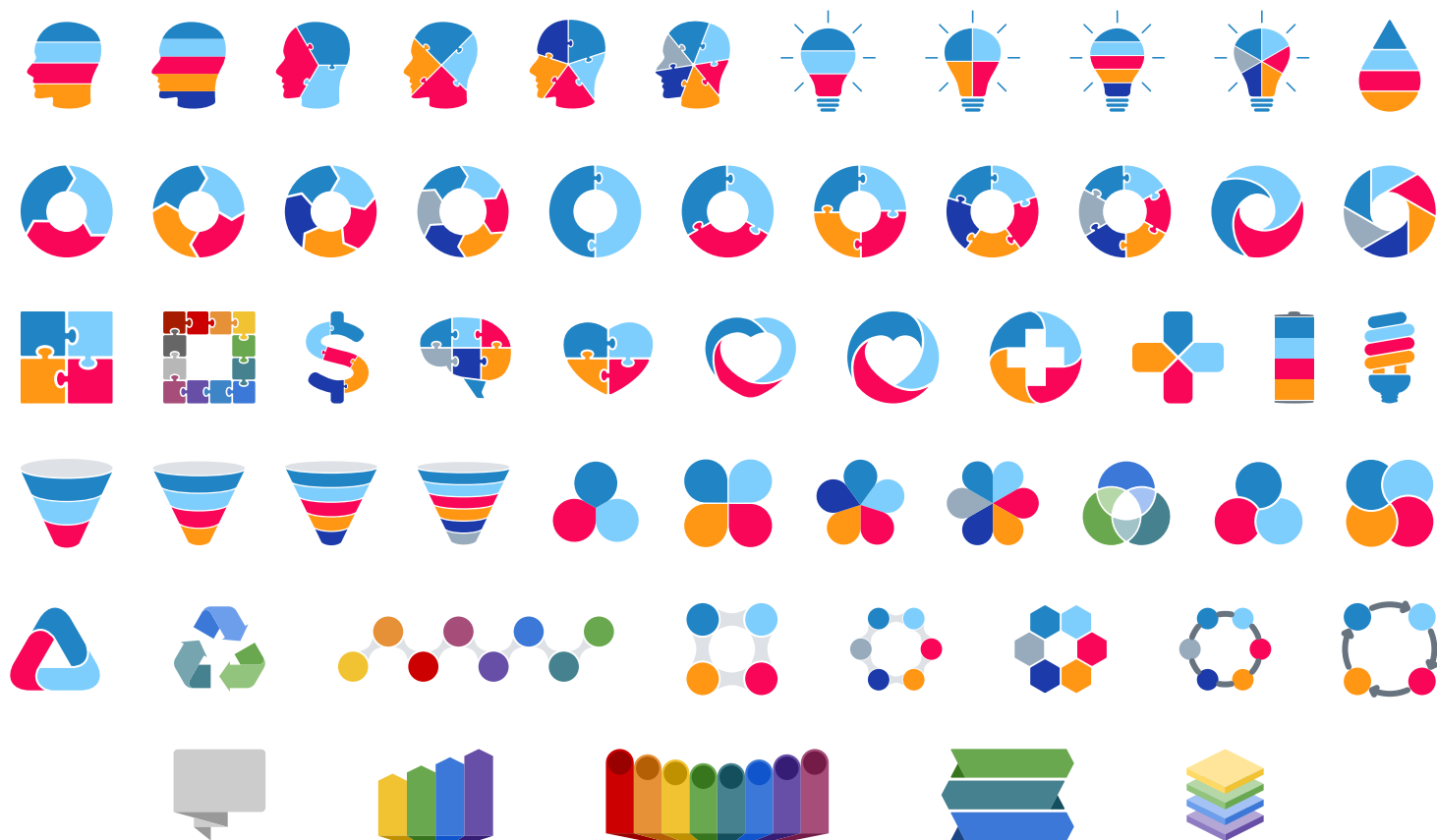
Isn't that nice? :)

Examples:



Find more icons at  
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# Diagrams and infographics



**Now you can use any emoji as an icon!**

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and many more...



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visuals