

# Options Pricing Project

DSO 530

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Yunchi Lee, Sheena Huang

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# Project Overview



## Key Focus

Understand the value of options until expiration.



## Approach

Employ supervised machine learning methods.



## Real-World Application

Assess suitability and practicality in financial markets.

# Supervised Learning

## Regression (Predicting: Value)

- Linear Regression  
(Lasso, Ridge)
- K Nearest Neighbors
- Decision Tree
- Random Forest

## Classification (Classifying: BS)

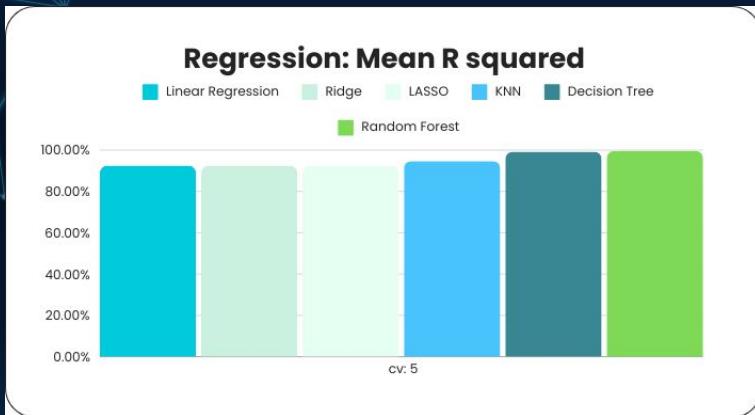
- Logistic Regression
- K Nearest Neighbors
- Decision Tree
- Random Forest

## Validation Method

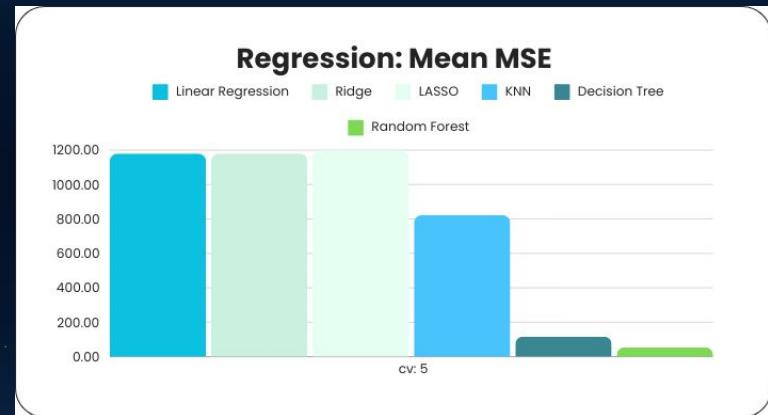
- KFold Cross Validation

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# Regression Models



R Square: The higher the better



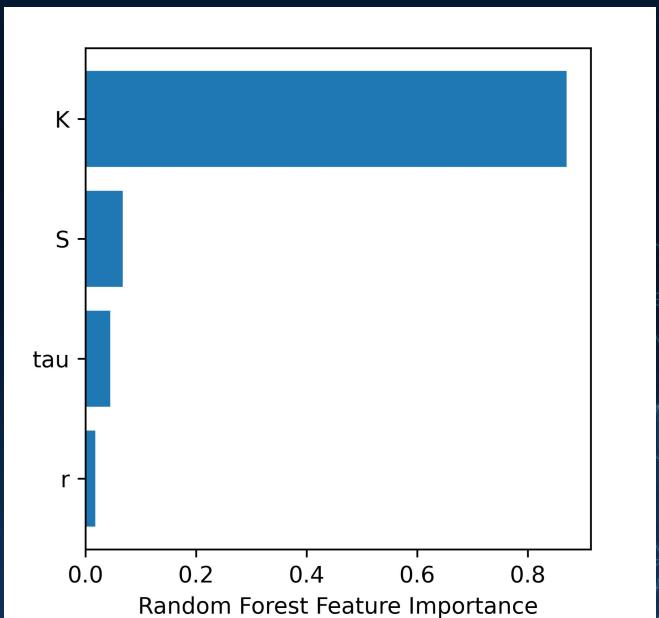
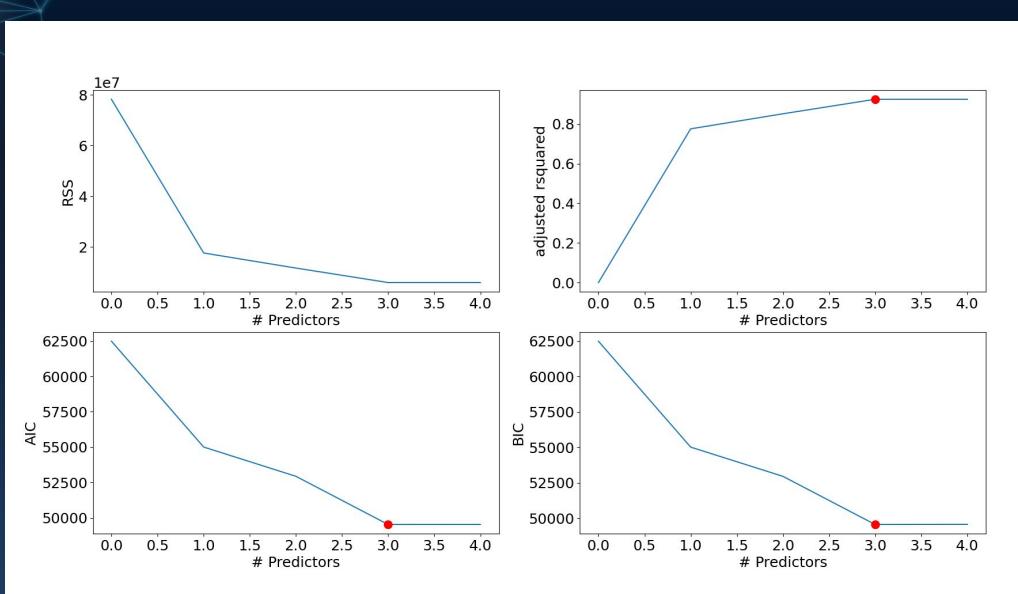
MSE: The lower the better

The best Model: **Random Forest**

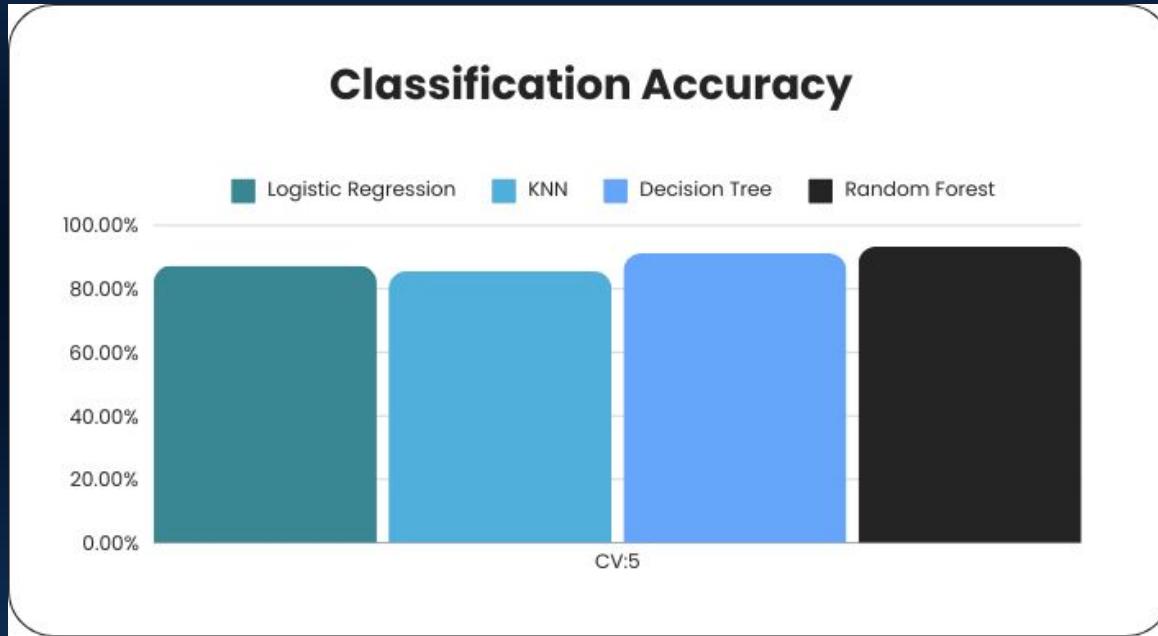
5-fold CV Mean R-Squared: 0.996, Mean MSE: 54.5

# Best Subset Selection

Selecting Parameters [S, K, tau, r] in Regression Models for predicting **Value**



# Classification Models



The best Model: **Random Forest**

# Business understandings

(1) In both prediction problems, would you argue if prediction accuracy or interpretation is more important? Why?

Predicting the Value (Regression Problem)		Predicting Over or Under Estimation by Black-Scholes Model (Classification Problem)		
	Prediction Accuracy	Interpretation	Prediction Accuracy	Interpretation
Importance	★★★★★	★★★	★★★	★★★★★

# Business understandings

(2) why do you think machine learning models might outperform Black-Scholes in terms of predicting option values?

## Non-linearity and Complexity

- Machine learning models, particularly those that can model complex nonlinear relationships can capture interactions between variables and adapt to non-linear patterns that the Black-Scholes model might not account for.

## Error Correction and Learning

- Machine learning models can continuously improve as they are exposed to new data. They can also be trained to minimize specific types of errors, enhancing their predictive performance over time.

## Adaptability to Market Conditions

- Financial markets are dynamic and influenced by a multitude of factors beyond the variables considered in the Black-Scholes model. Machine learning models can incorporate a much broader set of inputs.

# Business understandings

(3) Can you argue from a business perspective that all four predictor variables should be included in your prediction (i.e., no variable selection is necessary)?

K (Strike Price)	The strike price determines the price at which the underlying asset can be bought (for a call option) or sold (for a put option). It directly affects the option's intrinsic value, which is the difference between the current asset price and the strike price.
S (Current Asset Value)	Current asset value is a crucial determinant of an option's value, because changes in current asset value can impact the potential profitability of the option.
$\tau$ (Time to Maturity)	The time to maturity directly impacts the option's time value. Options with longer maturities have higher time values, leading to higher overall prices.
r (Annual Interest Rate)	The annual interest rate represents the time value of money, which is the opportunity cost associated with investing money in the option.

# Business understandings

(4) Are you comfortable about directly using your trained model to predict option values for Tesla stocks? Why?



## Limited Historical Data

- Tesla was established in 2003, which is a relatively young company. So there may be limited data available for training machine learning models.
- Insufficient training data can affect the model's ability to capture Tesla stocks' unique patterns and characteristics.



## Complexity of Market Dynamics

- Tesla stocks can exhibit a higher complexity and more dynamic behavior beyond the conventional scope of option pricing models.
- Market sentiment, company performance, regulatory influences, and macroeconomic conditions, which are all factors we did not include in training the model.



## Regional & Industry-Specific Variability

- The model was trained using the European call option pricing data from S&P 500, while Tesla is a US company in the highly volatile EV industry.
- It is challenging to generalize the model to predict stock prices under such different industry dynamics and geological locations.

# Conclusion

## ML Prediction



**Thank You**

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<b>Thanks slide</b>	You must keep it so that proper credits for our design are given
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## Purpose

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You can describe the topic  
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03

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04

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You can describe the topic  
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06

## Conclusions

You can describe the topic  
of the section here

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# Purpose statement

You can enter a subtitle here if  
you need it

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Awesome  
words



+++

# Purpose statement



## What about Venus?

Venus has a beautiful name, but also high temperatures



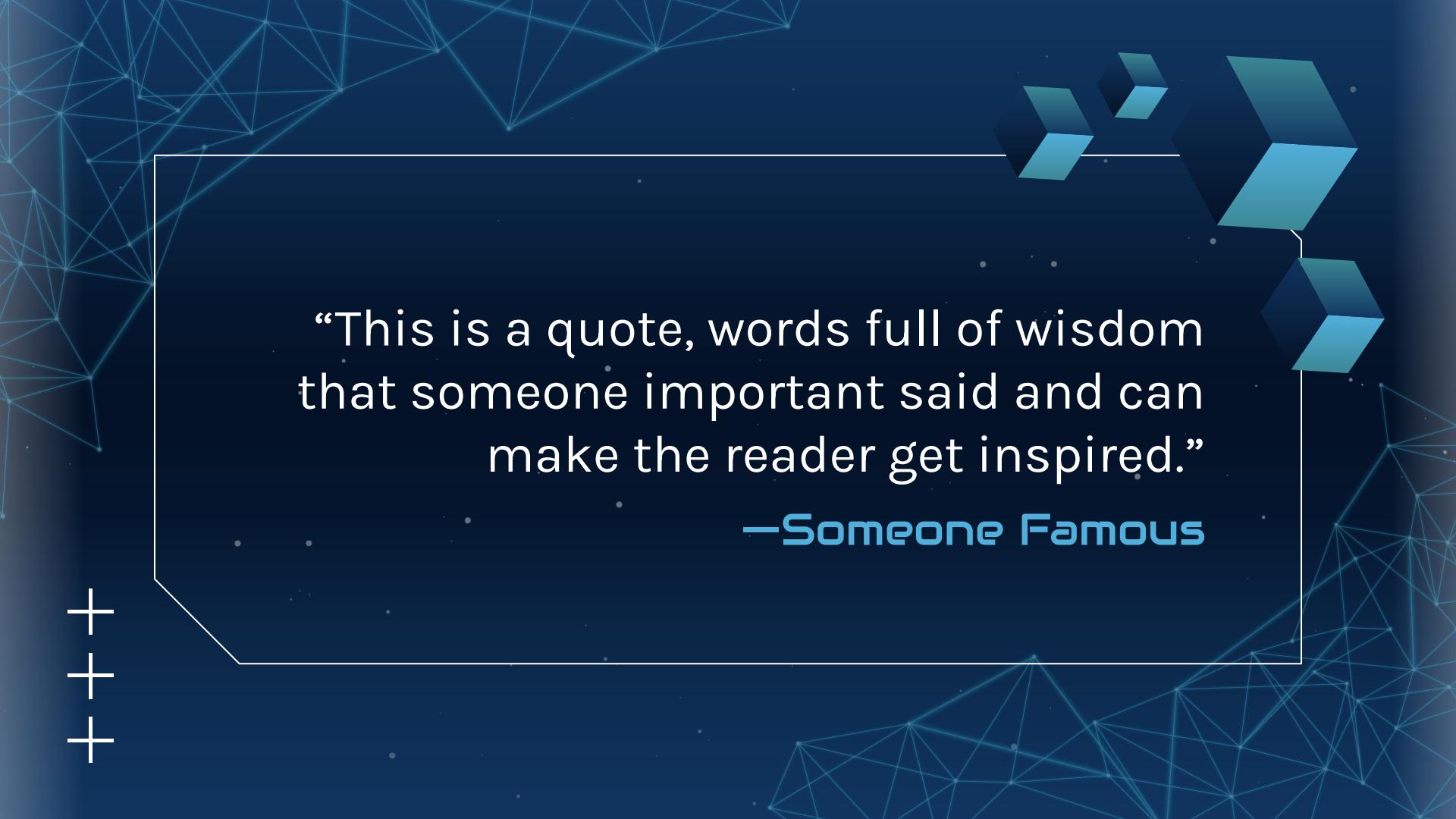
## What about Mercury?

Mercury is the smallest planet in the Solar System

## What about Mars?

Mars is actually a cold place. It's full of iron oxide dust





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

**—Someone Famous**

# Situation & problems statement

## Current situation

Jupiter is a gas giant and the biggest planet in the Solar System. It's the fourth-brightest object in the night sky. It was named after the Roman god of the skies and lightning

1

### Earth

Earth is the third planet from the Sun



2

### Mars

Despite being red, it's actually a cold place



3

### Mercury

Mercury is the smallest planet of them all



## Problems



# Hypotheses

## Hypothesis 1

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. The planet's name has nothing to do with the liquid metal

## Hypothesis 2

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

## Hypothesis 3

Jupiter is a gas giant and the biggest planet in the Solar System. It's the fourth-brightest object in the night sky. It was named after the Roman god of the skies and lightning



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A picture is  
worth a  
thousand words



# Study objectives



## Venus

Venus is the second planet from the Sun



## Mercury

Mercury is the closest planet to the Sun

## Mars

Despite being red, Mars is actually a cold place



## Saturn

Saturn is composed of hydrogen and helium



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# 150,000



Big numbers catch your audience's attention



# Literature review

- AUTHOR (YEAR). *Title of the publication*. Publisher
  - Mercury is the closest planet to the Sun and the smallest one in the Solar System
- AUTHOR (YEAR). *Title of the publication*. Publisher
  - Mars is full of iron oxide dust, which gives the planet its reddish cast
- AUTHOR (YEAR). *Title of the publication*. Publisher
  - Jupiter is a gas giant and the biggest planet in the Solar System
- AUTHOR (YEAR). *Title of the publication*. Publisher
  - Venus has a beautiful name and is the second planet from the Sun

# Theoretical framework

## Theoretical framework

### Key terms

- Mercury is small
- Earth harbors life
- Jupiter is quite big

### Relevant theories

#### Theory 1

Saturn is a gas giant  
and has rings

#### Theory 2

Neptune is the  
fourth-largest planet



### Framework

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

# Percentages



75%

## Neptune

Neptune is far away from us



85%

## Venus

Venus has a beautiful name



53%

## Saturn

Saturn is a gas giant and has rings

# Schedule

Jan	Feb	Mar	Apr	May	Jun
<b>TASK 1</b>	Neptune is an ice giant				
		<b>TASK 2</b>	Mercury is the smallest planet		
				<b>TASK 3</b>	Saturn is a gas giant
Task	Description	Date		Status	
Task 1	Mars is actually a cold place	Jan 1 - Mar 15		Completed	
Task 2	Earth is where we all live on	Feb 1 - Apr 30		In progress	
Task 3	Venus has a beautiful name	May 15 - Jun 30		Delayed	

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A picture  
always  
reinforces  
the concept

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





# Methodology



## Type of data

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

## Motives

Venus has a beautiful name and is the second planet from the Sun

## Data collection

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

## Specific sampling

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



# Locations

Venus

Venus has a  
nice name

Mercury

Mercury is a  
small planet

Mars

Mars is a very  
cold place



# Analysis & development



## Phase 1

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



## Phase 2

Venus has a beautiful name and is the second planet from the Sun. It's terribly hot!

# Analysis & development

10%

## Mercury

Mercury is quite a small planet

30%

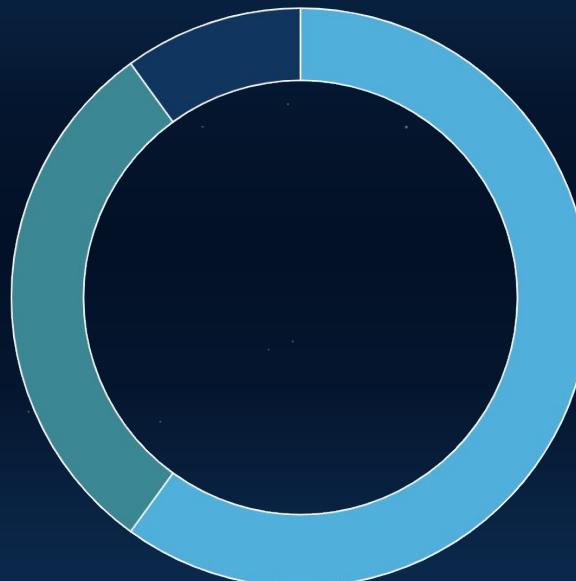
## Mars

Mars is actually a very cold place

60%

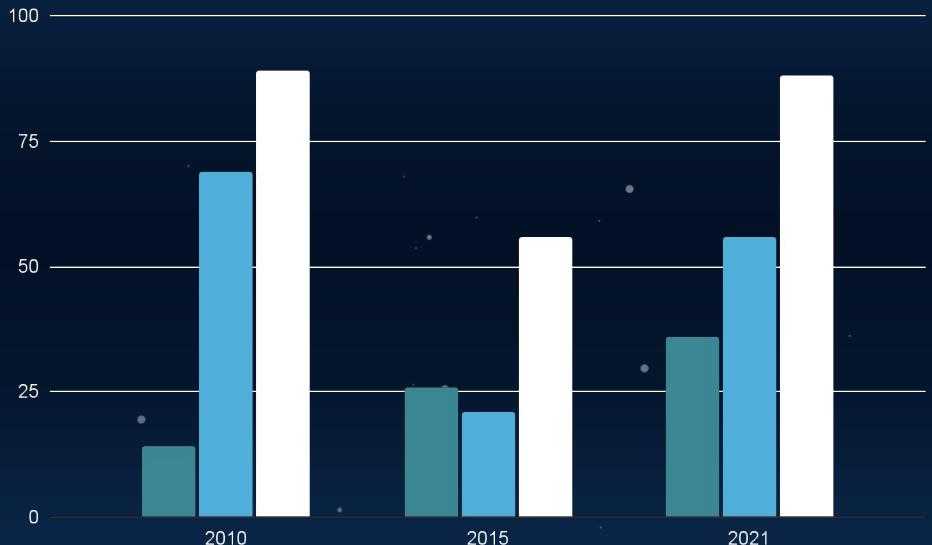
## Venus

Venus has a beautiful name



Follow the link in the graph to modify its data and then paste the new one here. [For more info, click here](#)

# Analysis of the results



Follow the link in the graph to modify its data and then paste the new one here. [For more info, click here](#)



## Mars

Despite being red, Mars is a cold place



## Venus

Venus is the second planet from the Sun



## Neptune

Neptune is the farthest planet from the Sun



# Discussion

## Discussion 1

Mars is actually a very cold place

1

## Discussion 2

Jupiter is the biggest planet of them all

2

## Discussion 3

Saturn is a gas giant and has rings

3

## Discussion 4

Venus is the second planet from the Sun

4

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# Conclusions

## Venus

Venus is the second planet from the Sun

## Jupiter

Jupiter is the biggest planet of them all

## Mercury

Mercury is the closest planet to the Sun

## Saturn

Saturn is composed of hydrogen and helium

## Mars

Despite being red, Mars is a cold place

## Neptune

It's the farthest planet from the Sun



# Evolution

01

Jupiter

Jupiter is the biggest planet of them all

02

Saturn

It's composed of hydrogen and helium

03

Mars

Mars is actually a very cold place

04

Venus

Venus is the second planet from the Sun



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

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- Woman wearing virtual reality simulator
- Man using a pair of smart glasses
- Woman wearing virtual reality simulator
- Website hosting with smiley man in suit
- Close up hand holding futuristic screen

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- Close up eye scanning
- Side view woman working on digital monitors
- Young man with virtual reality simulator and woman testing
- Website hosting concept with futuristic screen

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#ffffff

#10355f

#3b8794

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Pana



Amico



Bro



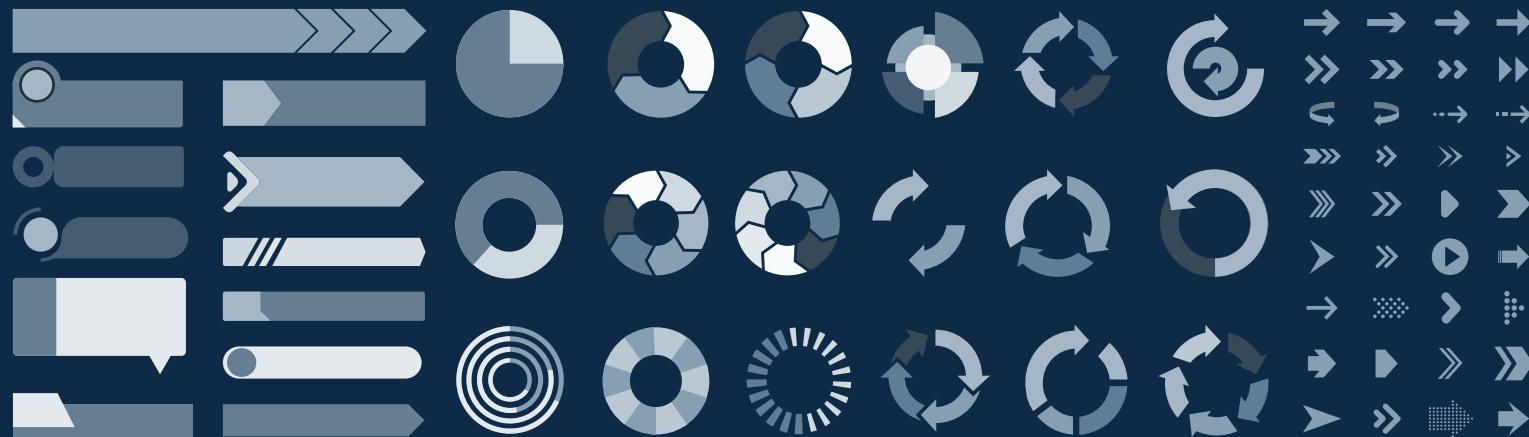
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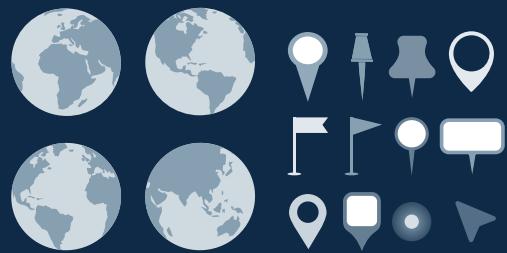


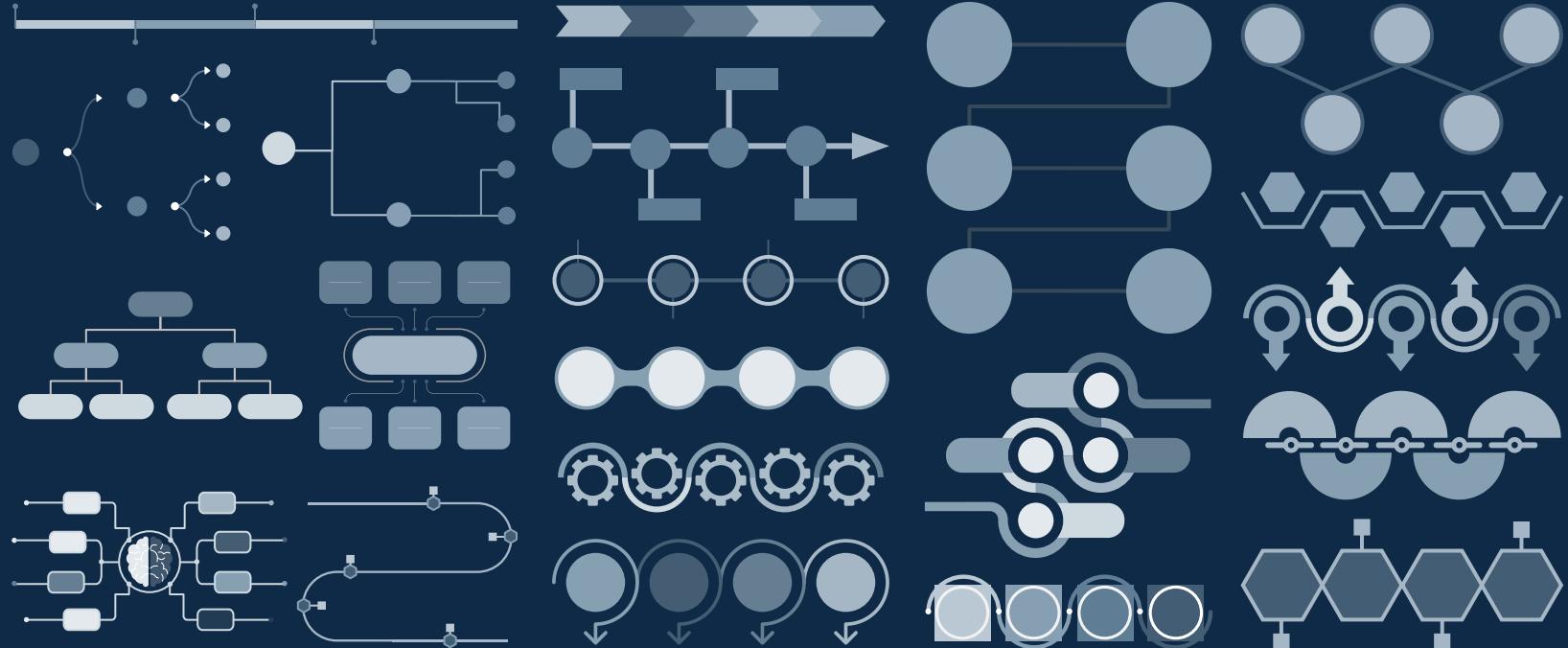
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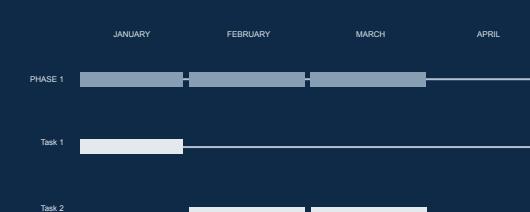
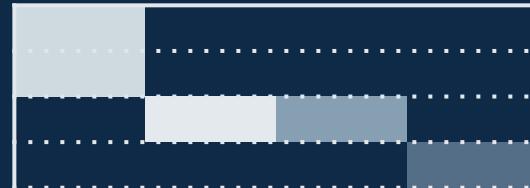
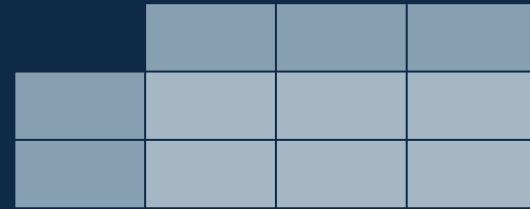
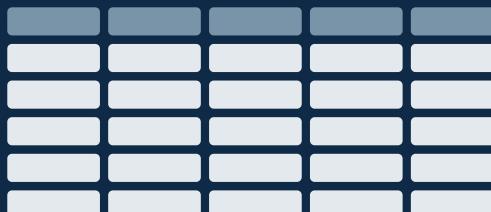
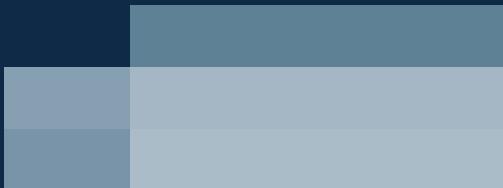
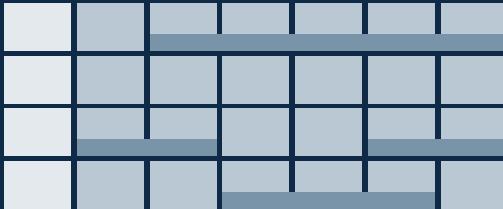
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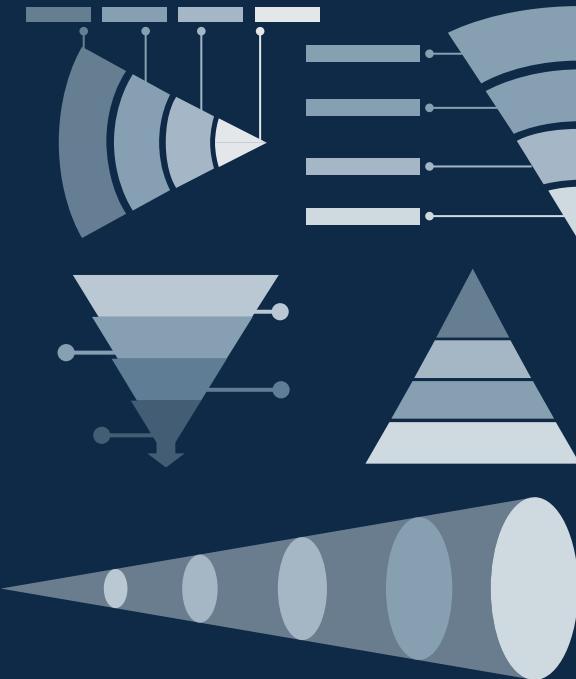
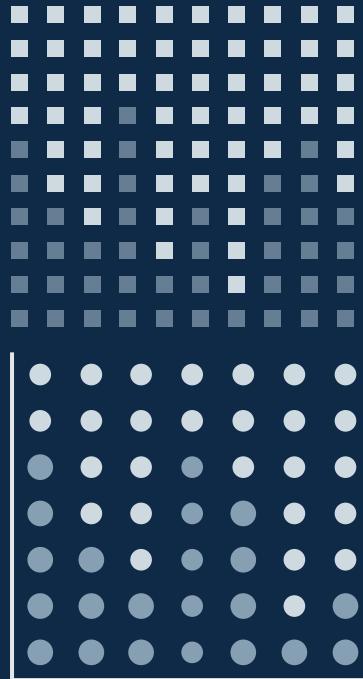












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## Medical Icons



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## Avatar Icons



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## Performing Arts Icons



# Nature Icons



# SEO & Marketing Icons



