Random Forest Classifier

Here is where your presentation begins

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Introduction

One of the most popular algorithms to implement due to its simplicity and general accuracy is Random Forest.

Random Forest is an ensemble of decision trees, in which each tree is comprised of data drawn from a sample of a data set with a replacement called a bootstrap sample.

Combines predictions from individual trees to make final decisions

Developed by Leo Breiman and Adele Cutler in 2001

Decision Tree Review

A decision tree is a supervised machine learning algorithm that makes decisions by following a tree-like structure of conditions:

Structure: Consists of nodes (decision points), branches (outcomes), and leaves (final decisions)

Decision Process: Starts at the root node and follows paths based on feature values until reaching a leaf node

Splitting Criteria: Uses metrics like Gini impurity, entropy, or information gain to determine optimal splits

Interpretability: Highly interpretable - can follow the logic path for any prediction

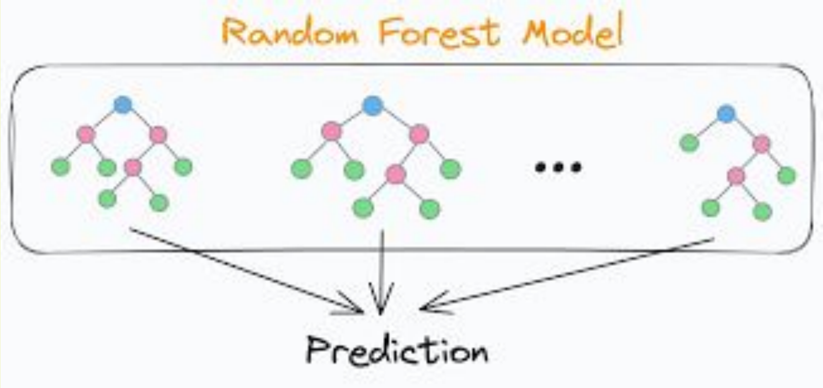
Visualization: Can be visualized as a flowchart, making it accessible to non-technical stakeholders

Decision trees work by recursively partitioning the data space, asking questions like "Is feature X > threshold Y?" at each node. The goal is to create segments where the samples are as homogeneous as possible regarding the target variable.

In other words, they work great with the data used to create them but are not flexible when it comes to classifying new samples.

Random Forest Builds Upon Decision Trees

While one decision tree might make errors due to the specific way it was trained, combining many trees with different perspectives helps cancel out individual mistakes and produces more robust predictions.
Random Forests essentially sacrifice some of the interpretability of decision trees to gain significant improvements in predictive power and stability.



Supervised or Unsupervised

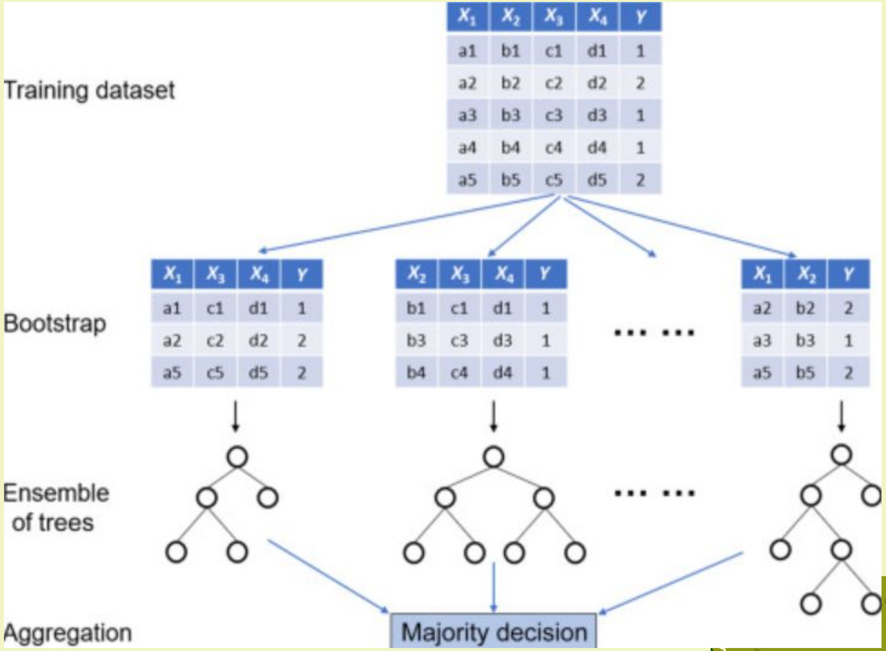
Random Forest is primarily supervised learning, using labeled training data to learn patterns and make predictions on new, unseen data.

Unsupervised methods exist that leverage the concept of Random Forest such as using the proximity matrix to perform clustering

Random Forest

Random forest can be broken down into 4 stages

1. Bootstrapping (Bagging Technique)
2. Feature Randomness (Feature Bagging)
3. Tree Construction
4. Voting for Classification



Bootstrapping

The algorithm randomly selects subsets of the training data (with replacement) to train individual decision trees.

Each tree is trained on a slightly different dataset.

Creates multiple subsets of training data through random sampling with replacement
Each subset trains a different decision tree

Feature Randomness

When splitting a node in a decision tree, only a random subset of features is considered rather than all available features.

This reduces correlation between the trees and improves generalization.

At each split, only considers a random subset of features
Typically $\sqrt{p}$ features (where p is total number of features)

Tree Construction

Each decision tree in the forest is trained independently on its bootstrapped dataset.

Trees are grown to full depth (or stopped based on pre-defined conditions like max_depth, min_samples_split).

Each tree learns different patterns due to different training samples and feature selections meaning trees are decorrelated due to different training samples and feature subsets

Aggregation/Voting

Once all trees are trained, they make independent predictions on new data.

The final prediction is determined by majority voting, meaning the class that receives the most votes from individual trees is chosen.

Key Parameters

n_estimators: Number of trees in the forest
max_features: Maximum number of features considered for splitting
max_depth: Maximum depth of trees
min_samples_split: Minimum samples required to split a node
min_samples_leaf: Minimum samples required at a leaf node
bootstrap: Whether to use bootstrap samples

Advantages vs Disadvantages

Robust to overfitting compared to individual decision trees
Handles high-dimensional data well
Automatically ranks feature importance
Works well with both categorical and numerical data
Handles missing values effectively
No assumption about data distribution
Parallel processing capability

Less interpretable than single decision trees
Computationally intensive for large datasets
Slower prediction than simpler models
May overfit on noisy datasets
Biased in favor of features with more levels (categorical variables)

Real World Applications

- Healthcare: Disease prediction, diagnostic assistance
- Finance: Credit scoring, fraud detection
- Marketing: Customer segmentation, churn prediction
- E-commerce: Product recommendations
- Environmental Science: Climate modeling, species distribution
- Manufacturing: Quality control, predictive maintenance
- Cybersecurity: Threat detection, anomaly identification

Random forest vs Gradient Boosting

- **Ensemble approach**: Builds trees sequentially (boosting)
- **Tree building**: Each new tree focuses on correcting errors made by previous trees
- **Error correction**: Explicitly minimizes errors through gradient descent on loss function
- **Training process**: Usually uses shallow trees (weak learners)
- **Overfitting resistance**: More prone to overfitting, requires careful tuning
- **Speed**: Slower to train due to sequential nature
- **Tuning difficulty**: More hyperparameters to tune, requiring more careful optimization

Random Forest: When you need a robust model with minimal tuning, have very high dimensional data, or when training speed is important
Gradient Boosting: When you need the highest possible predictive performance and have time for proper hyperparameter tuning

Random Forest vs KNN

- Random Forest creates a model during training, while KNN is "lazy" and only computes during prediction
- Random Forest naturally handles feature importance, while KNN treats all features equally
- Random Forest generally performs better on high-dimensional data
- KNN is conceptually simpler but can be computationally expensive for large datasets

Which one works better depends on your specific use case, dataset characteristics, and computational constraints.

Common Questions

How many trees should I use in my Random Forest?
This is often determined experimentally, but typically ranges from 100-500 trees
More trees generally lead to better performance up to a point of diminishing returns
Computational resources become a limitation with very large numbers of trees

How does Random Forest handle imbalanced data?
By default, not very well - tends to favor majority class
Solutions include using class weights, undersampling/oversampling techniques, or setting sample_weight parameter

When should I choose Random Forest over other algorithms?
When interpretability is important but single decision trees are too unstable
With mixed data types (categorical and numerical features)
When you have a moderate amount of features but don't want to perform extensive feature selection

Main Take Away

- Random Forest is a versatile ensemble learning method
- Combines multiple decision trees with randomization
- Offers excellent performance with minimal tuning
- Provides feature importance rankings
- Works well across various domains and data types
- Balances accuracy and overfitting

Example

https://colab.research.google.com/drive/1ew7BgbgbHiHZ9JAcuDhuSy6F2p-Y9qyZ?usp=sharing

The end.

Our academic areas

Mars

Despite being red, Mars is a cold planet

Venus

Venus is the second planet from the Sun

Neptune

Neptune is the farthest planet from the Sun

Mercury

Mercury is the closest planet to the Sun

Saturn

Saturn is a gas giant with several rings

Jupiter

Jupiter is the biggest planet of them all

Our mission and vision

Mission

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

Vision

Venus has a beautiful name and is the second planet from the Sun. It's hot and has a very poisonous atmosphere

Our values

Mars

Mars is actually a very cold place

Neptune

Neptune is very far from the Sun

Jupiter

Jupiter is the biggest planet of them all

Saturn

Saturn is a gas giant and has several rings

Our success

Mercury

Mercury is the closest planet to the Sun and the smallest of them all

75%

Venus

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

50%

Mars

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

25%

98,300,000

Big numbers catch your audience’s attention

Awesome words

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

Statistics

Venus

Venus has a beautiful name

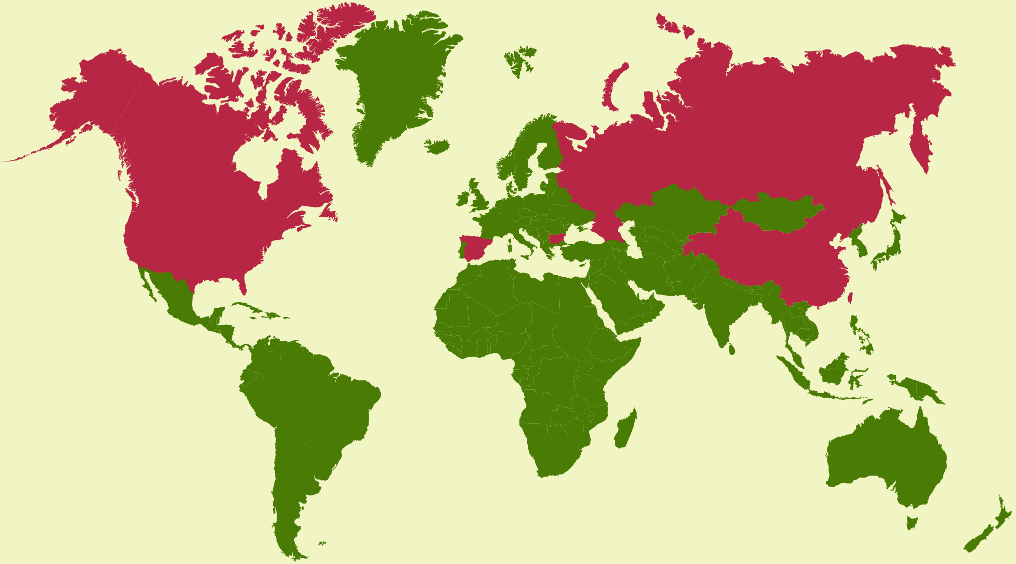
Mercury

It's the closest planet to the Sun

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

Protected areas in world

Number of protected areas	
Equal to or greater than 20	
Equal to or less than 19	



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Our goals

Objectives	Description
Academic success	Mercury is the closest planet to the Sun
	Mars is actually a very cold place
Community	Venus is the second planet from the Sun
	Jupiter is the biggest planet of them all
Diversity	Saturn is composed of hydrogen and helium
	Neptune is the farthest planet from the Sun

Student progress

01

Earth is the only planet known to harbor life

02

Saturn is a gas giant and has several rings

03

Despite being red, Mars is actually a cold planet

04

Mercury is the closest planet to the Sun

05

Neptune is very far away from Earth

06

Jupiter is the biggest planet of them all

Enrollment process

01

Venus is the second planet from the Sun

02

Despite being red, Mars is actually a cold place

03

Jupiter is the biggest planet of them all

04

Saturn is composed of hydrogen and helium

05

Neptune is the farthest planet from the Sun

Special reminders

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

Thanks!

Do you have any questions?

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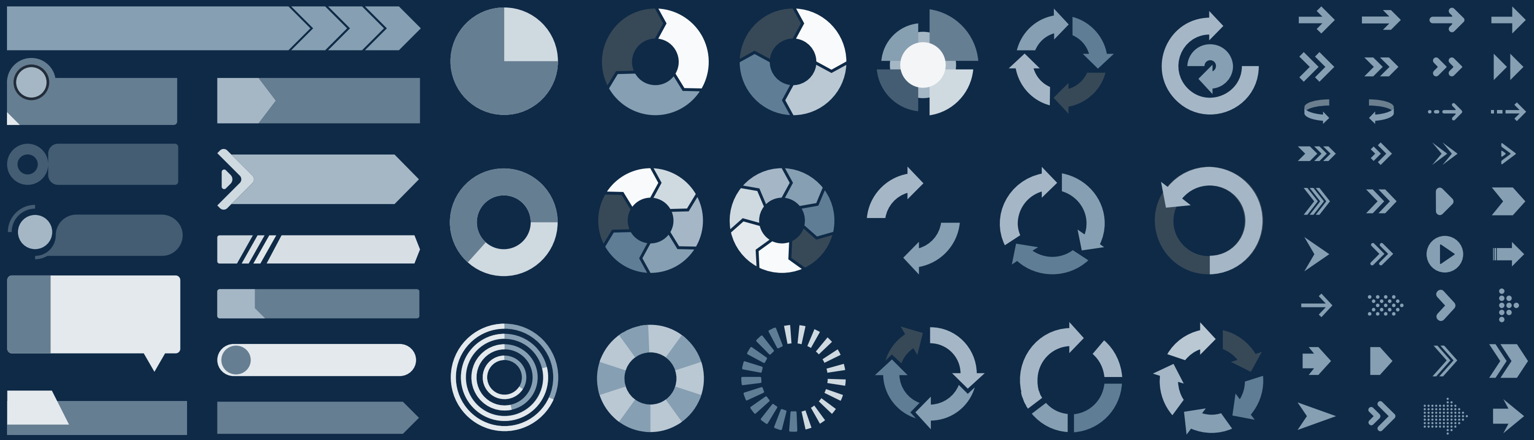

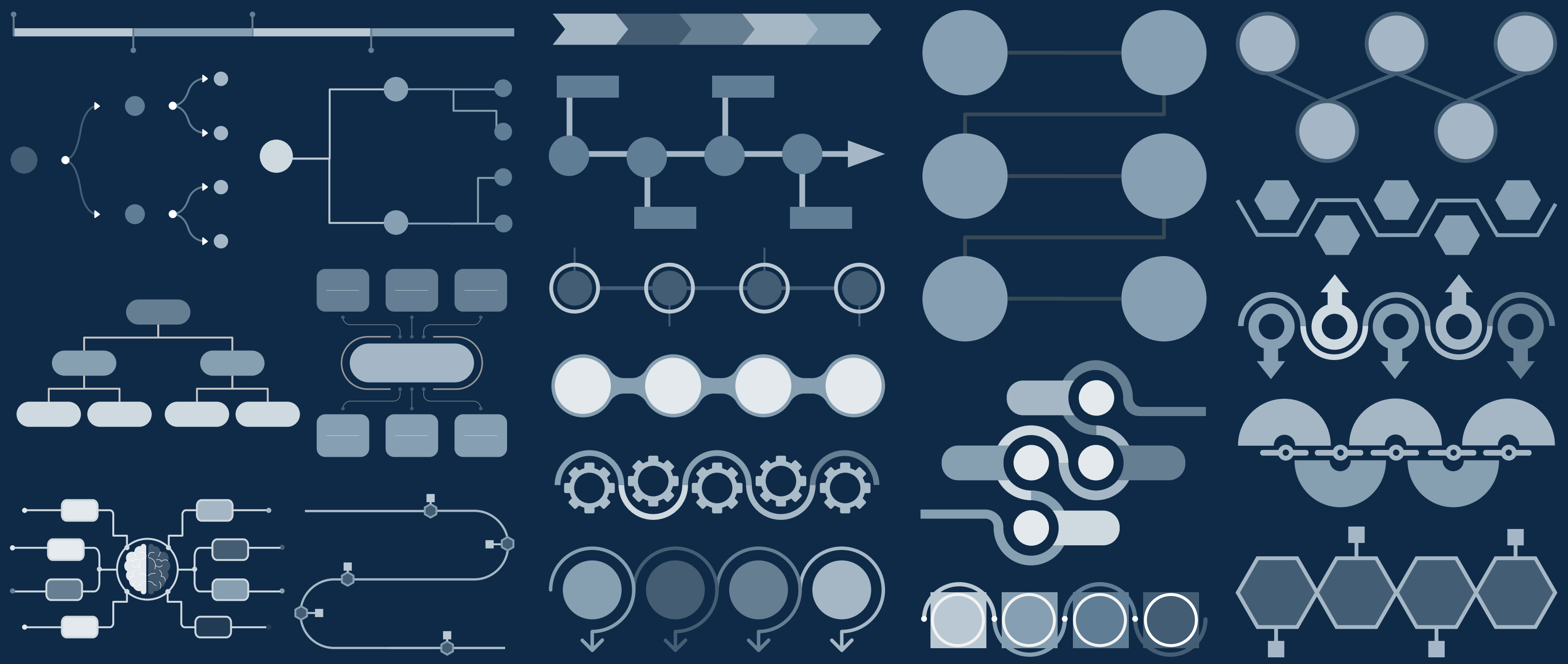


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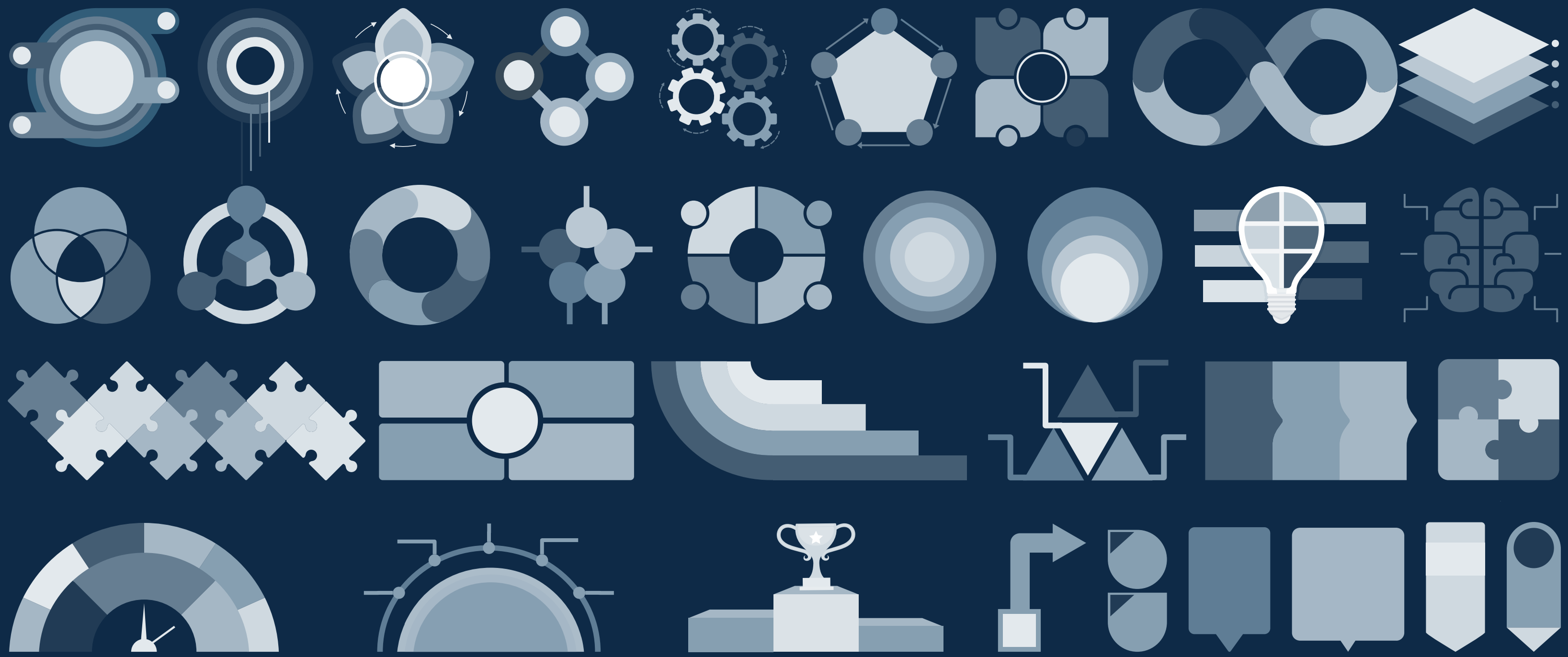

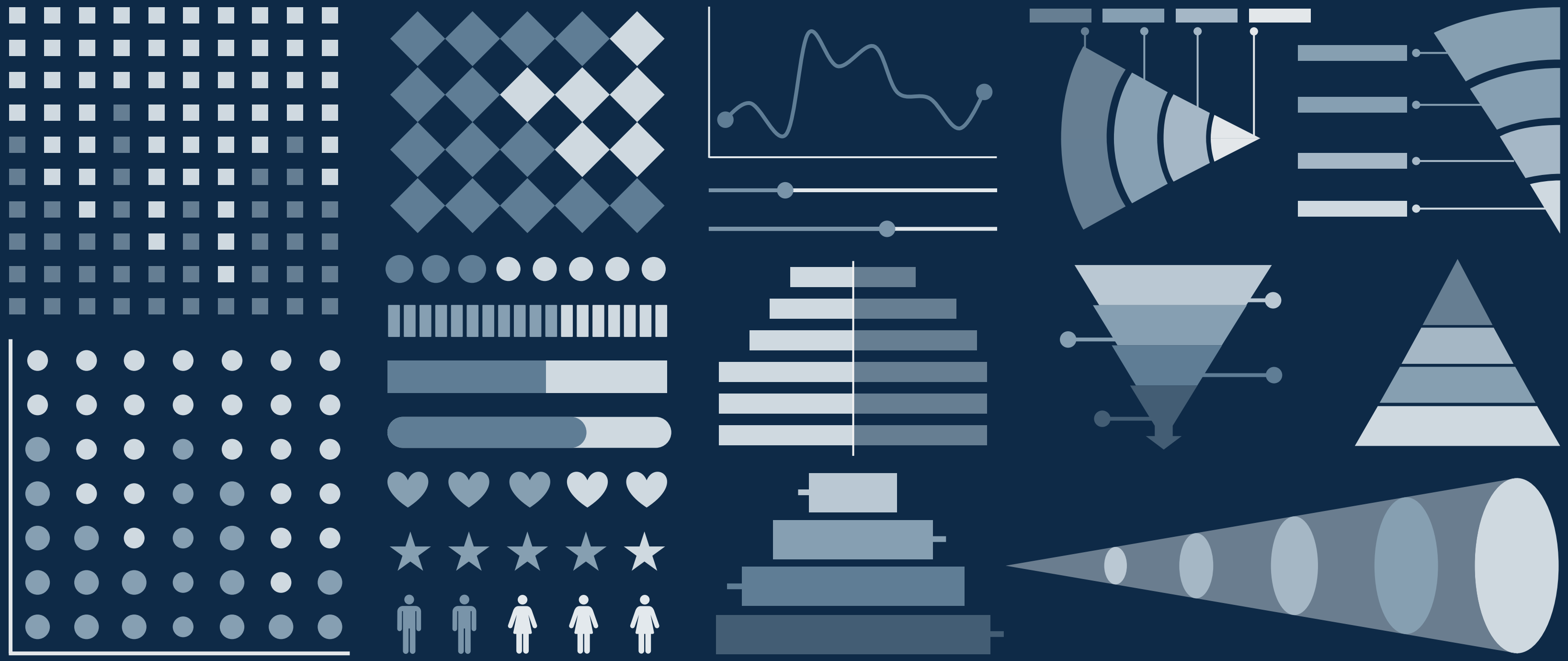

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