

Traffic Accident Prediction In Hamburg

Accident Prophet



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16.10.2023

OUR TEAM



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Mathematician

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Biochemist

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Till Meineke

Biochemist & Data Analyst

<https://github.com/TillMeineke>



“1.35 million individuals lose their lives in traffic accidents every year.”

—**World Health Organization (WHO)**

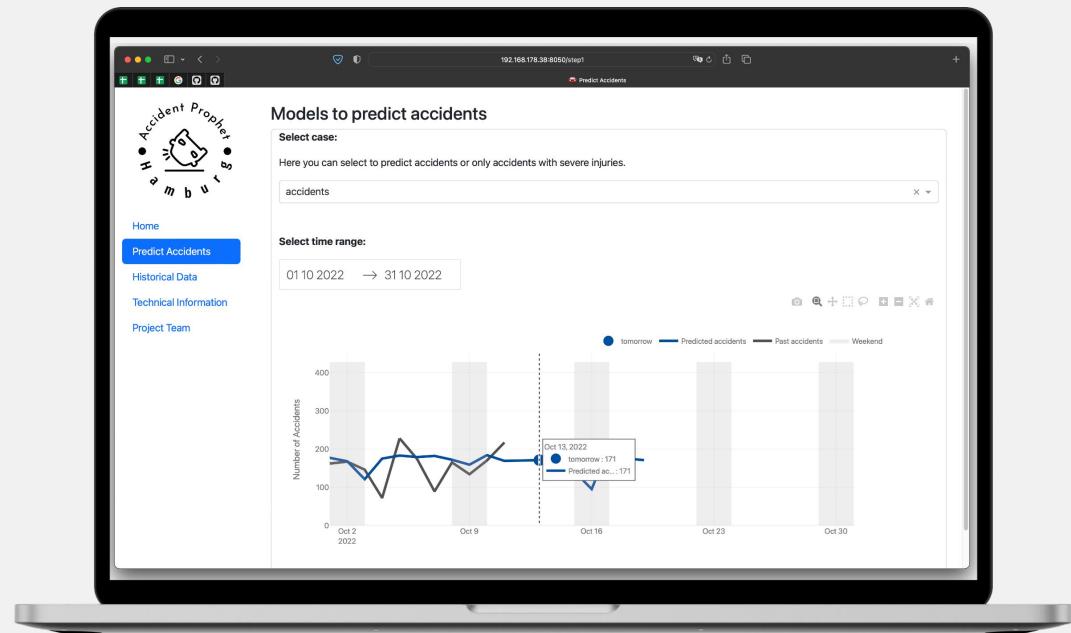


“Traffic crashes totalled EUR 31.5 billion for German society in 2020.”

—**ROAD SAFETY REPORT 2021**

MOTIVATION & PRODUCT

- ◆ Predict traffic accidents in Hamburg
- ◆ Resource planning for police and hospitals
- ◆ Reduce time for police to arrive on accident



DATA SOURCES



Accidents Data

- 2009 - 2022
- Accidents: 909273
- Features : 47
- Date, time, location, age, no. injured



Weather Data

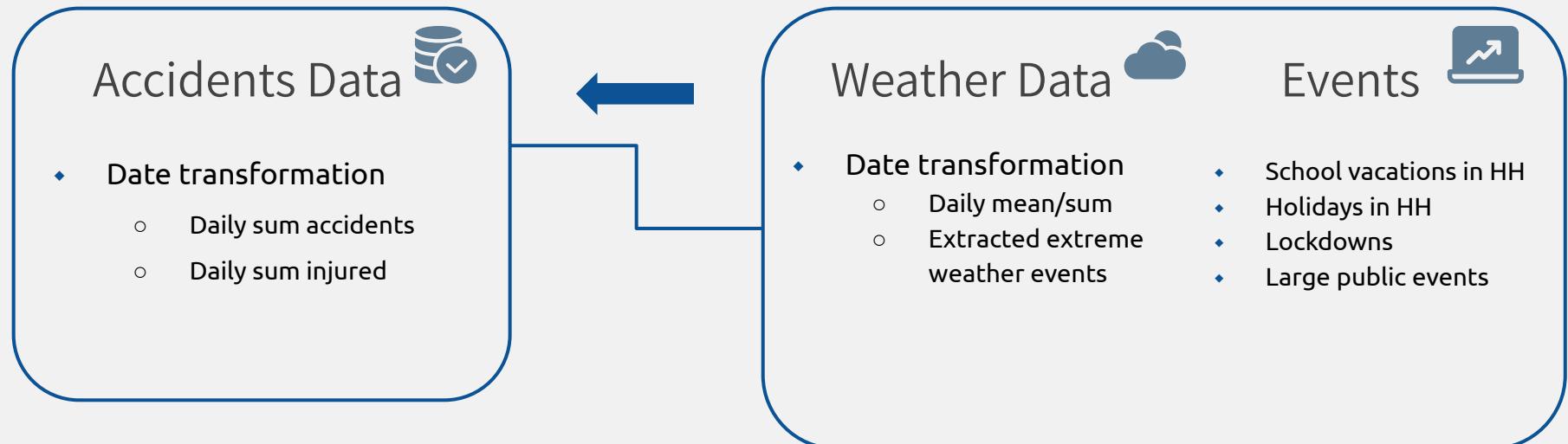
- Numerical weather data
- Weather phenomena



Events

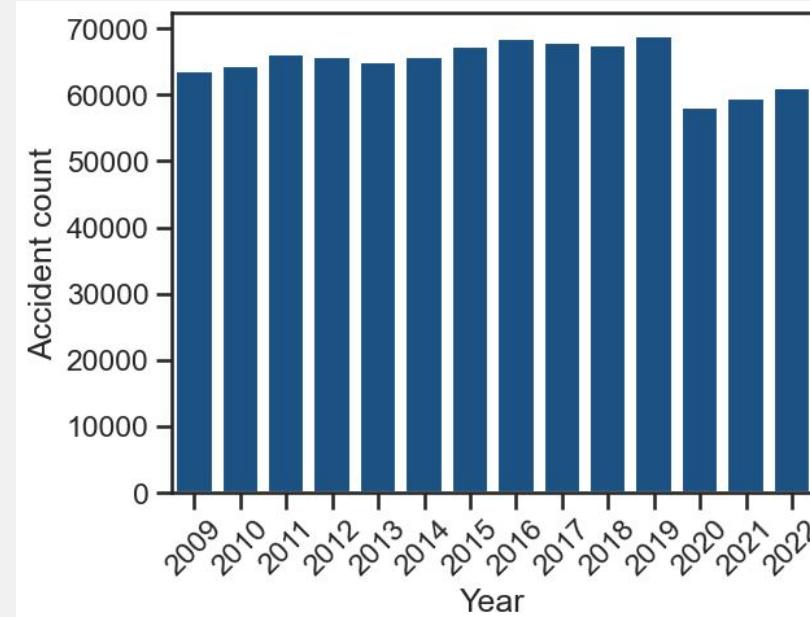
- School vacations in HH
- Holidays in HH
- Large public events

DATA ENGINEERING



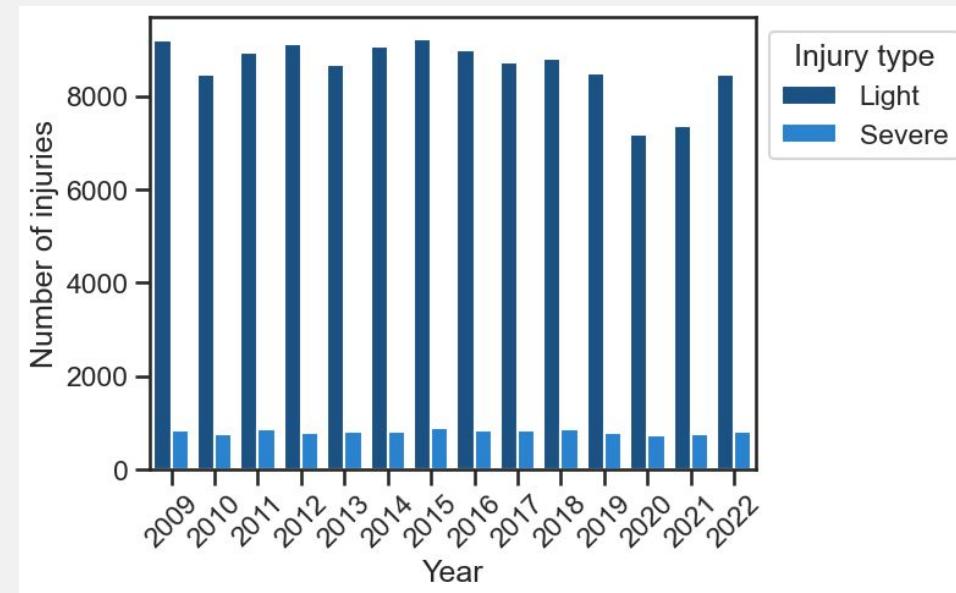
TRAFFIC ACCIDENTS **PER YEAR**

+65000
ACCIDENTS
in Hamburg



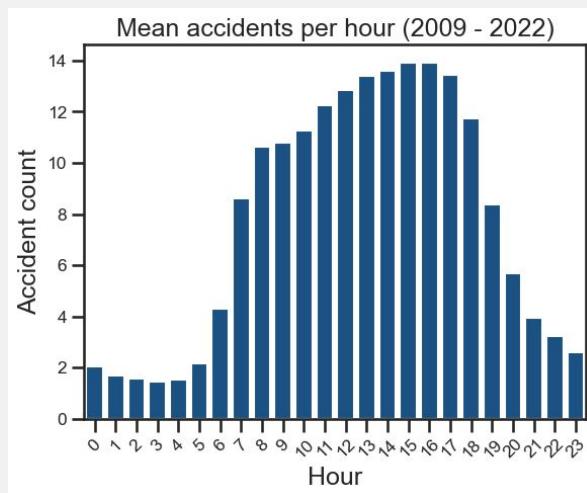
TRAFFIC INJURIES PER YEAR

+**8500** light
+**800** severe
INJURIES
in Hamburg

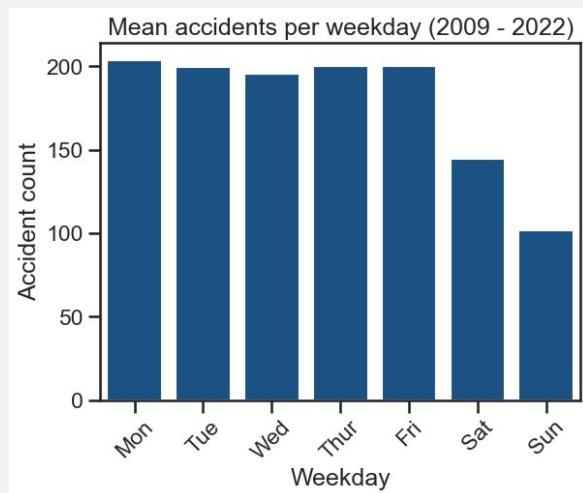


TIME PATTERNS

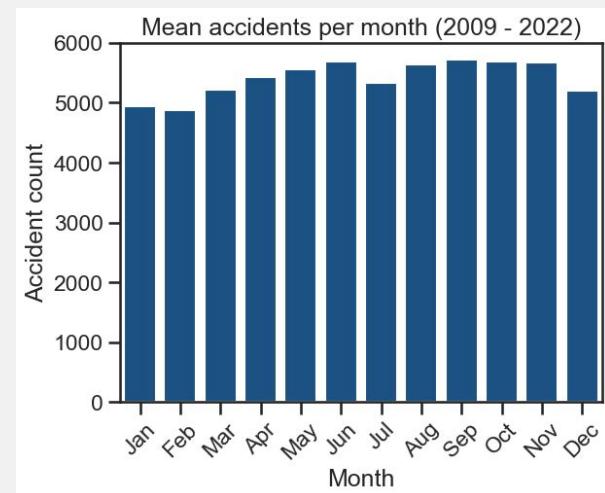
Hour



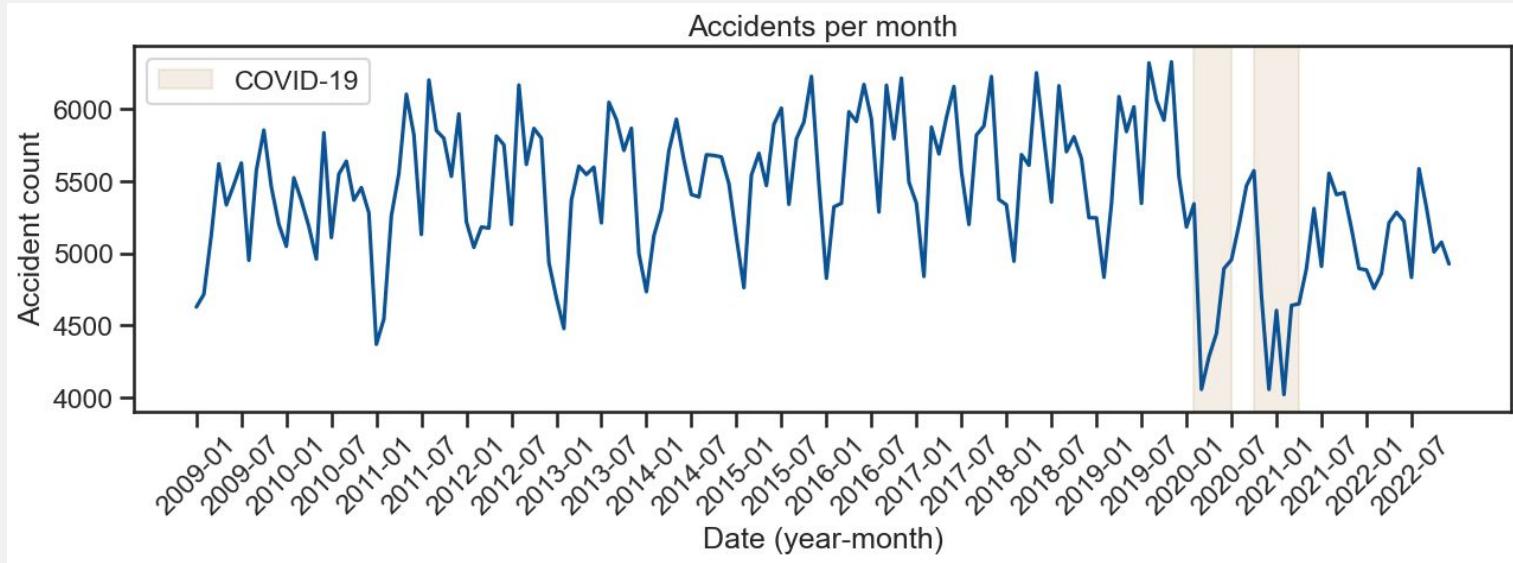
Weekday



Month



COVID-19 IMPACT



PREDICTION MODELS



SARIMAX

- Classic time-series model
- Autoregressive component (AR)
- Moving average (MA)
- Seasonality
- Additional features



Prophet

- Time-series model
- Additive regression model
- Trend, Seasonality,
Holidays
- Additional features

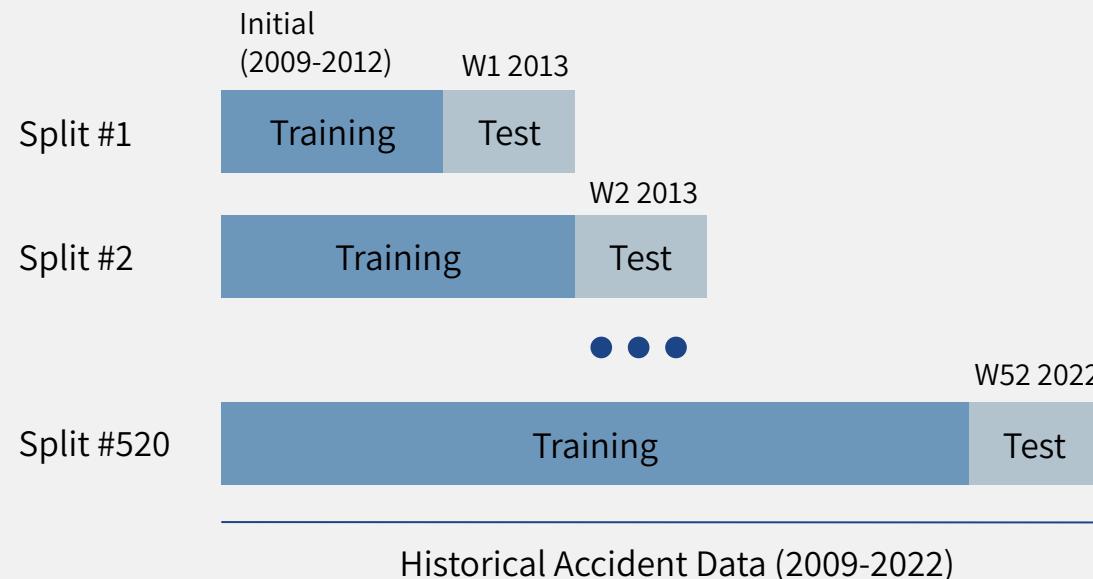


LightGBM

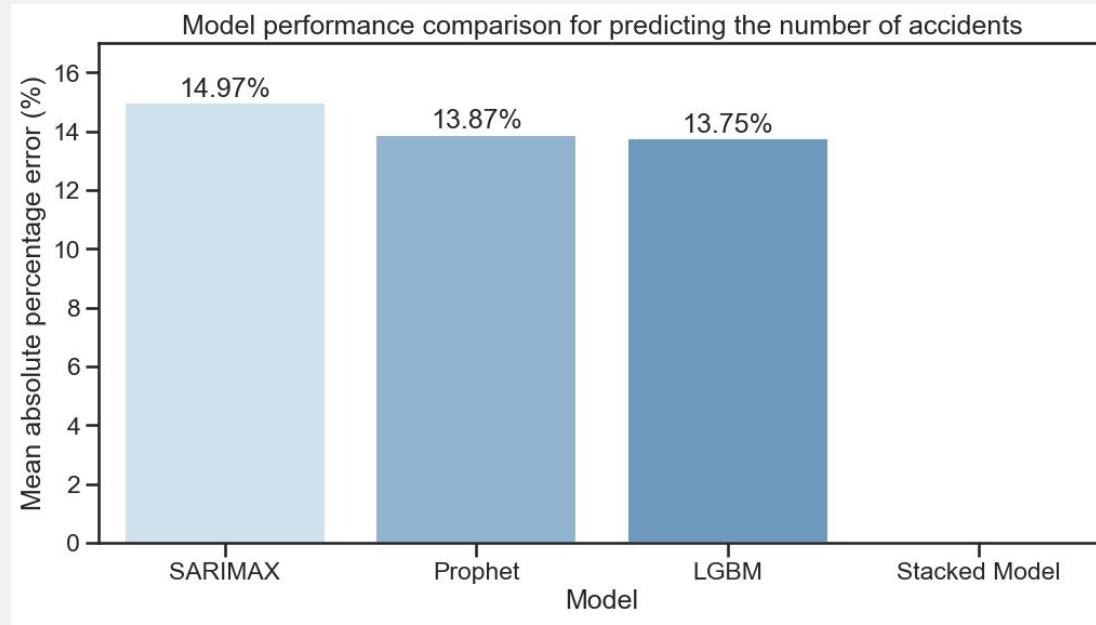
- Gradient boosting model
- Tree based learning

EVALUATION METHOD

- Cross validation with weekly splits
- Mean absolute percentage error (MAPE) as metric



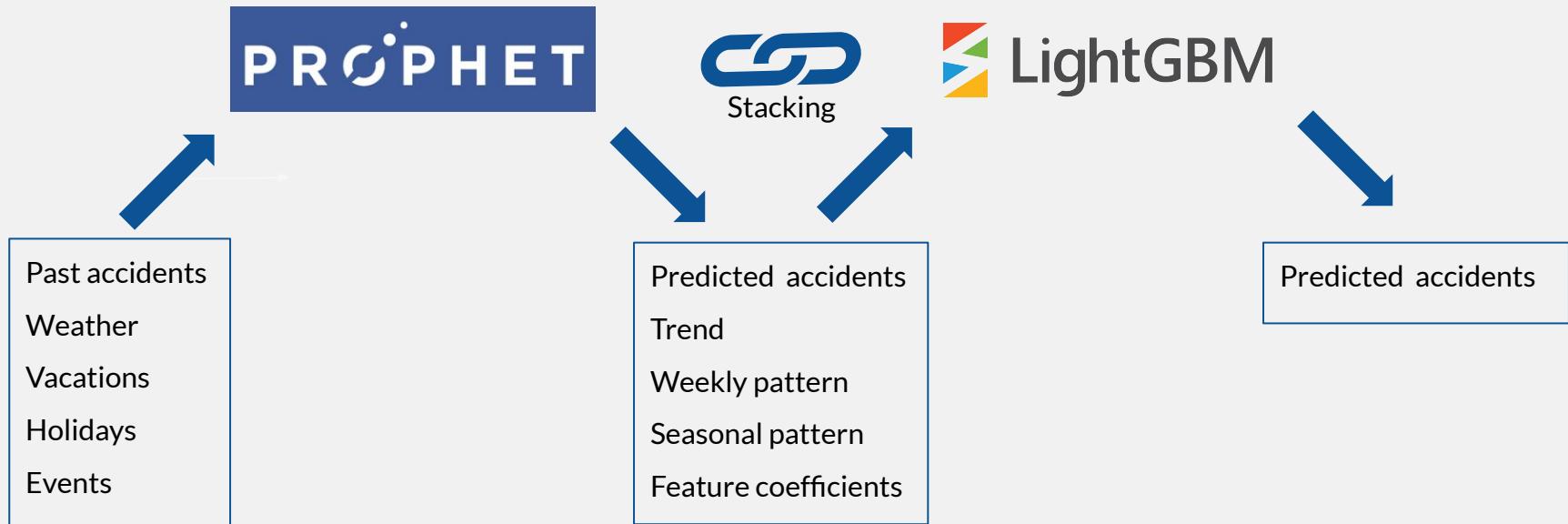
MODEL EVALUATION



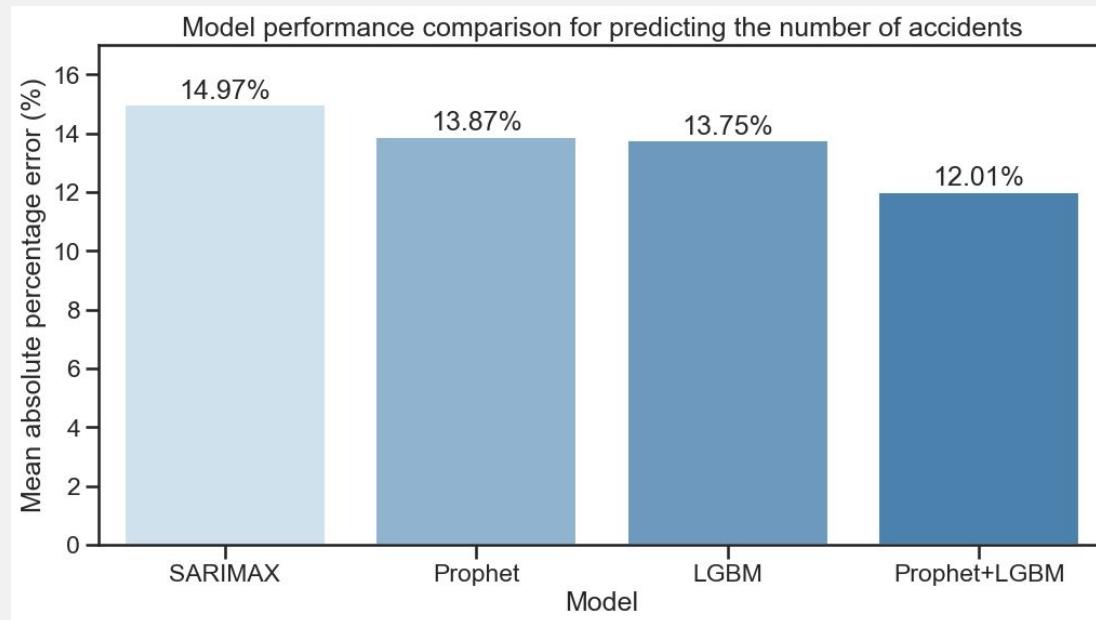
FORECAST MODEL



FORECAST MODEL



MODEL EVALUATION



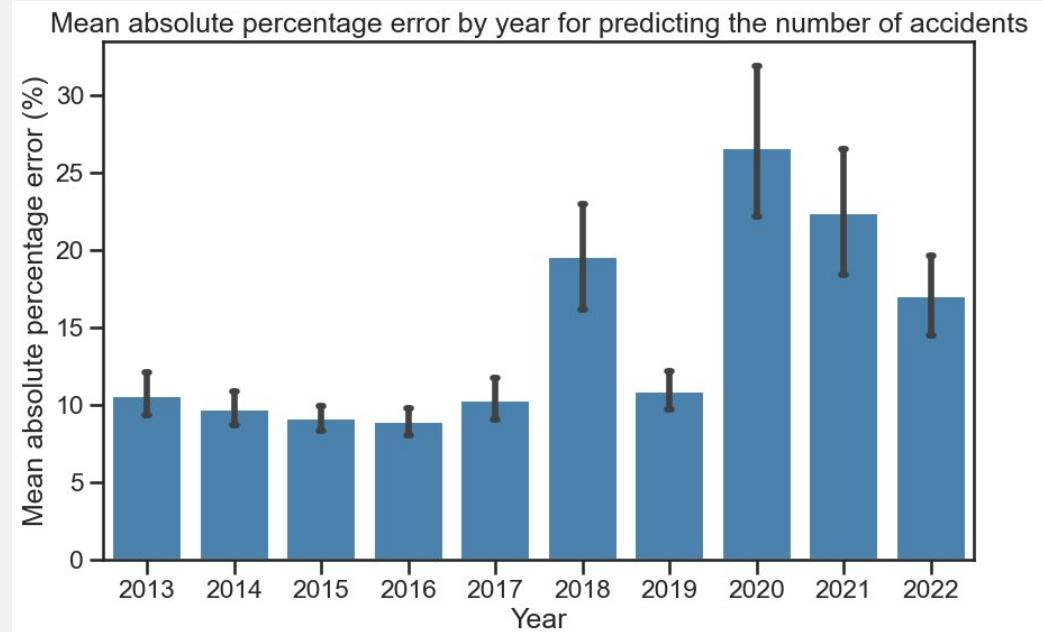
Tuning and **EVALUATION**

Tuning

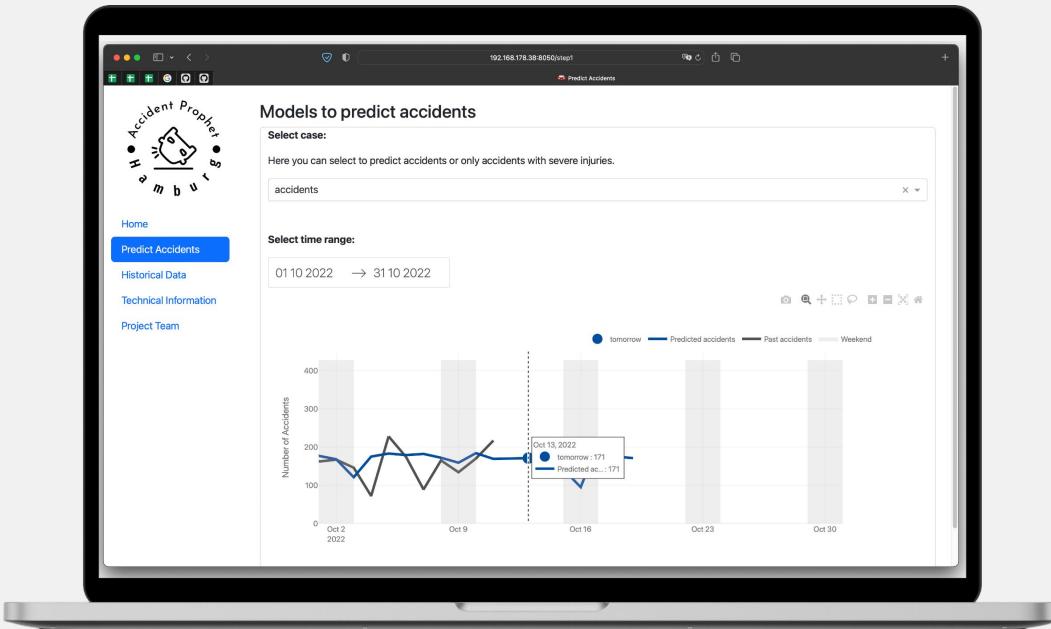
- Best regressor combinations chosen by cross validation
- Hyperparameter tuning

Evaluation

- Only 12% MAPE for predicting the number of daily accidents
- Significant drop of prediction quality during Covid-pandemic
- 29.6% MAPE for predicting the number of daily injured people



DASHBOARD **LIVE DEMO**



FUTURE WORK



Implement real-time data
(weather, traffic etc.)



Improve model,
try more sophisticated models



User feedback



Monitoring of dashboard effect

THANKS!

Do you have any questions?



Felix Geyer

Mathematician

<https://www.linkedin.com/in/felix-geyer-ds/>



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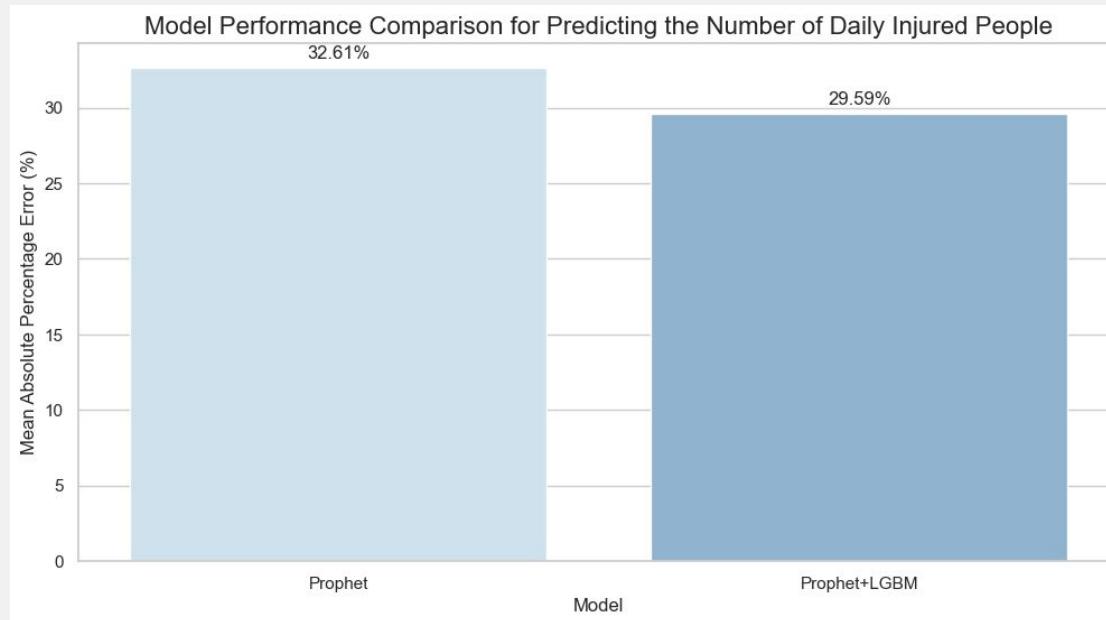


Till Meineke

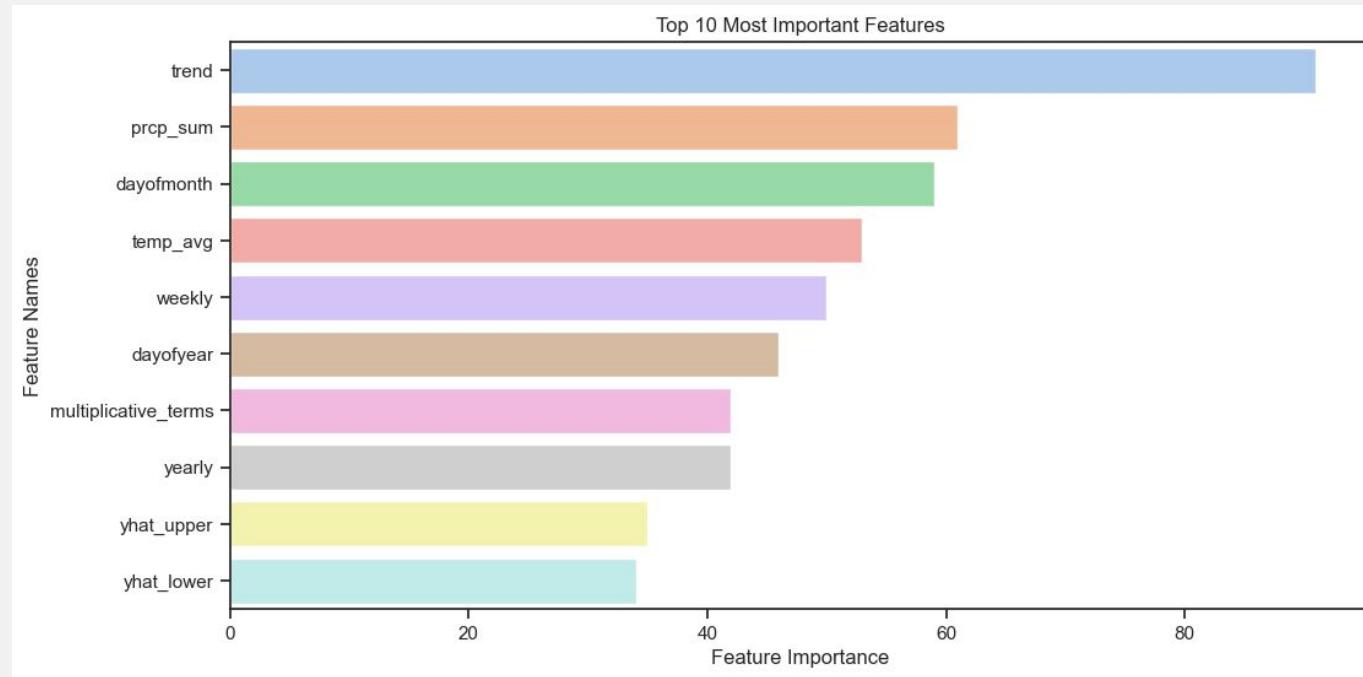
Biochemist & Data Analyst

<https://github.com/TillMeineke>

MODEL EVALUATION



MODEL EVALUATION



FUTURE WORK



Implement real-time data (weather, traffic etc.)



Improve model, try more sophisticated models



User feedback



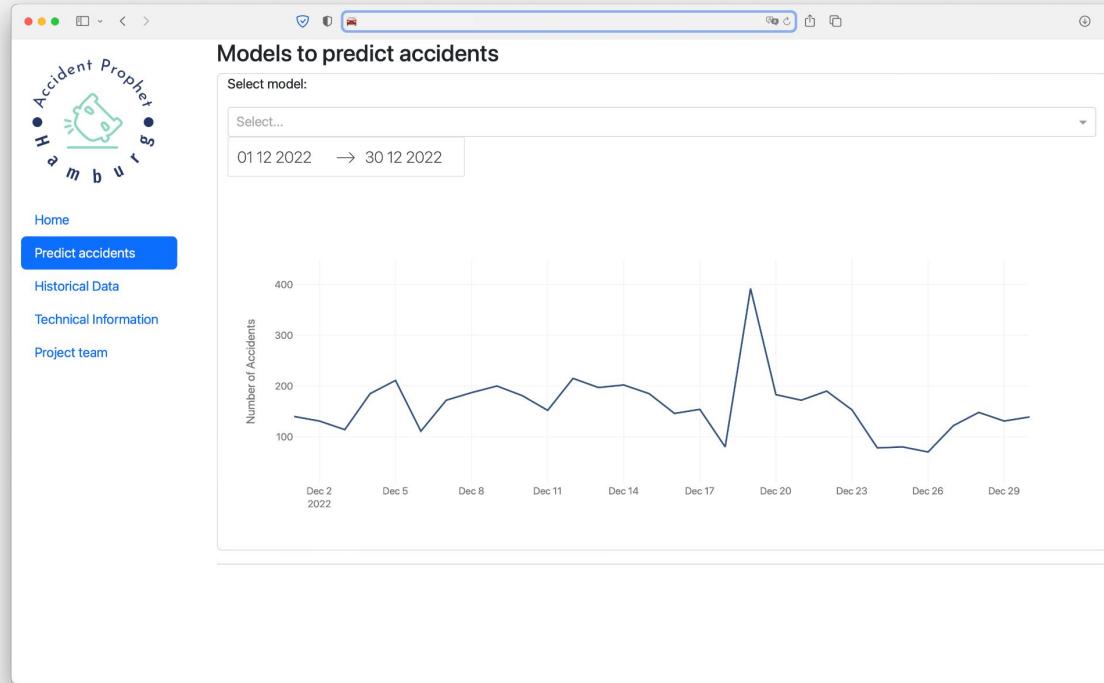
Monitoring of dashboard effect

“

Traffic Accident Prediction **In Hamburg**

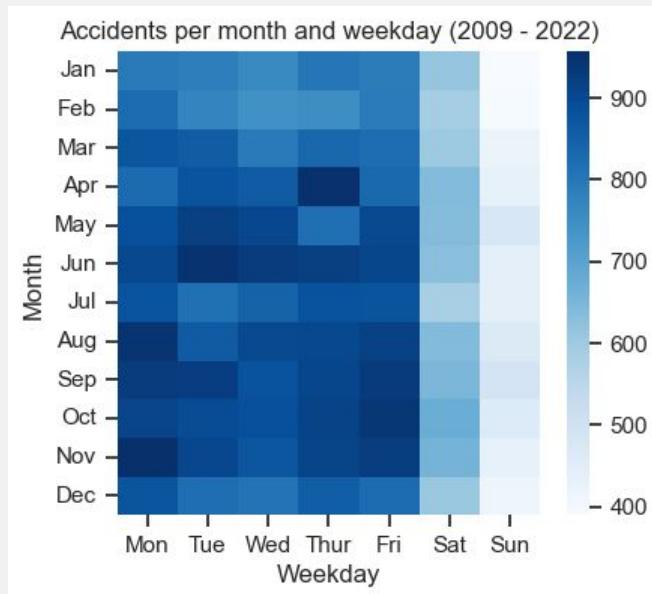


DASHBOARD for accident prediction

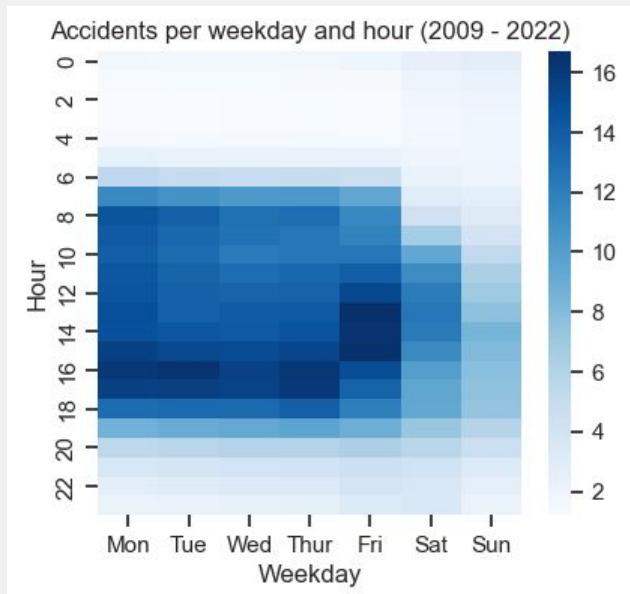


MONTHLY AND HOURLY PATTERNS

Month



Hour



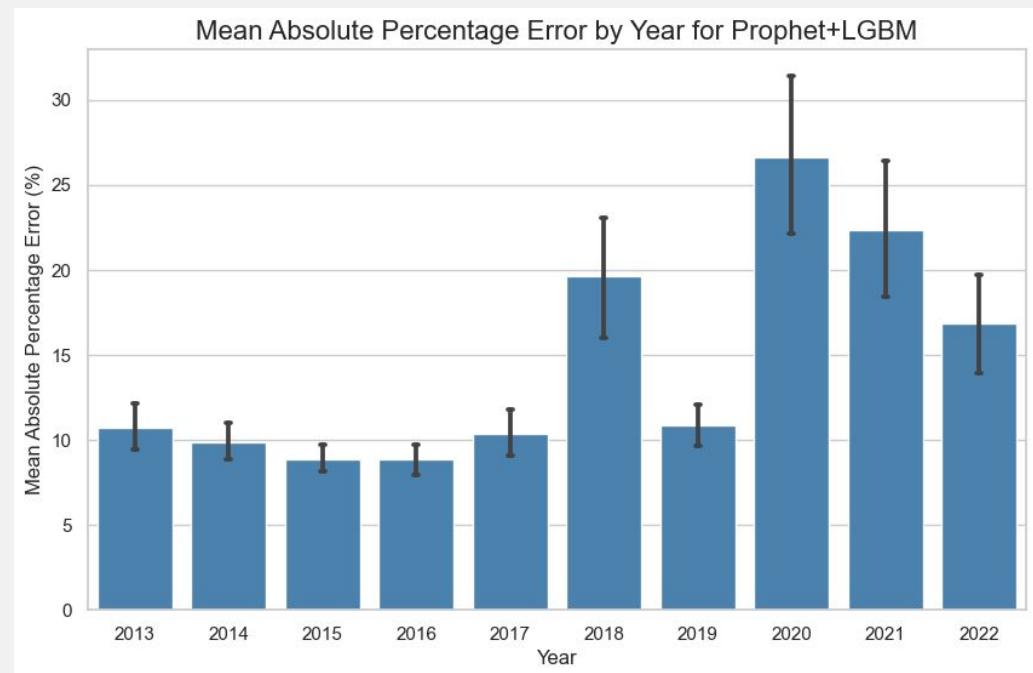
Tuning and **EVALUATION**

Tuning:

- Picked best regressor combinations by cross-validation
- Hyperparameter tuning

Evaluation:

- Only 12% MAPE for predicting the number of daily accidents
- Significant drop of prediction quality during Covid-pandemic
- 29.59% MAPE for predicting the number of daily injured people
- Challenges in predicting



FORECAST MODEL



Prophet:

- Additive non-linear model identifying general trend and seasonalities
- Incorporate vacations, events and additional regressors
- Goal: Get a good fit for periodic behaviour and linear relationships in the data

LightGBM:

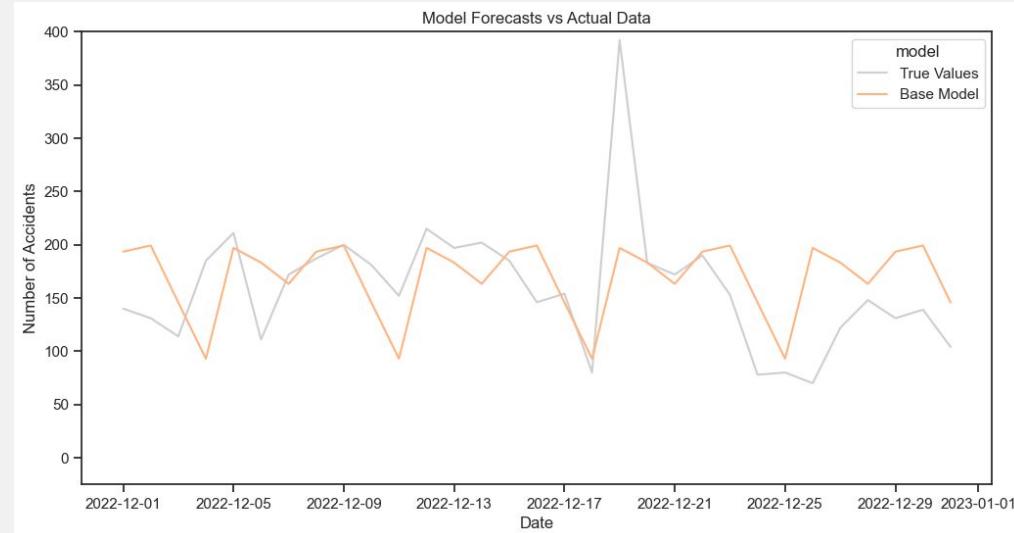
- State of the art gradient boosting framework using tree based learning algorithms
- Goal: Improve the results of prophet using non-linear relationships in the data

BASELINE MODEL



SEASONAL WINDOW AVERAGE FORECAST

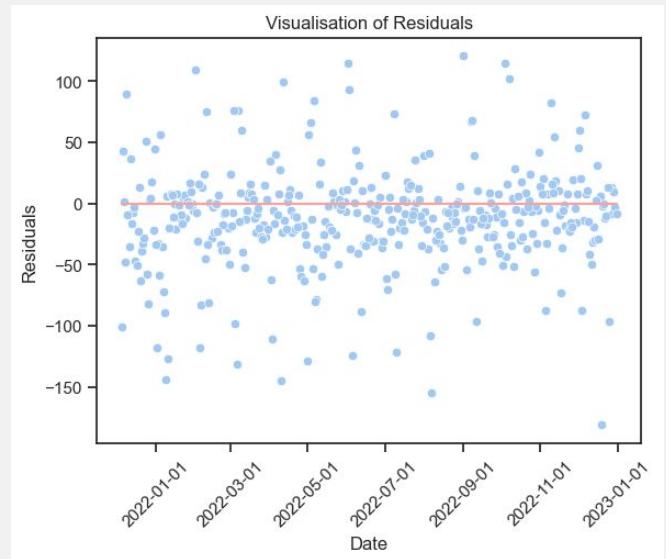
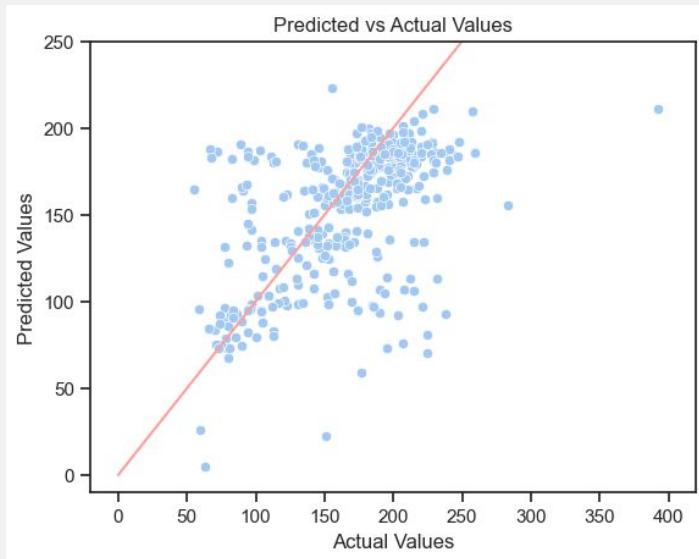
- ◆ Mean accident counts of previous same 4 weekdays
- ◆ We capture only the weekly seasonality





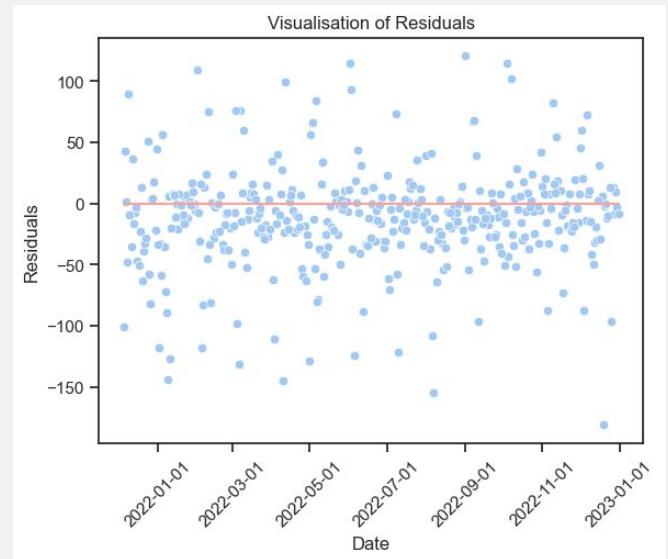
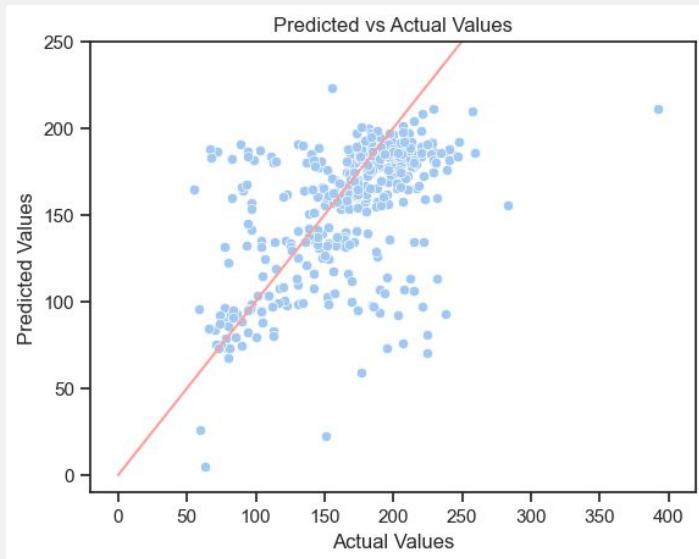
MODEL EVALUATION

PROPHET in Depth



MODEL EVALUATION

PROPHET in Depth



MOTIVATION & **PRODUCT**

- ◆ Predict traffic accidents in Hamburg
- ◆ Resource planning for police and hospitals



- Motivation (C)
- Product/ Dashboard (C)
- Data sources/ data engineering/ feature engineering (C)
- Data, Modeling pipeline (A)
- EDA (A)
- Modeling (F)
- Evaluation (F)
- Showcase dashboard (T)
- Outlook (T)



FORECAST MODELS



Baseline model: Averaging by weekday

Classical Timeseries-model: **SARIMAX**

Additive regression model: **Prophet**

- Combination of AI-approach with Prophet
lightGBM with Prophet

Result:

- Prophet outperforms other models**

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
40	30	31	1	2	3	4	5
50	6	7	8	9	10	11	12
30	13	14	15	16	17	18	19
40	20	21	22	23	24	25	26
40	27	28	29	30	31	1	2

Baseline Model

WHAT IS **DONE**

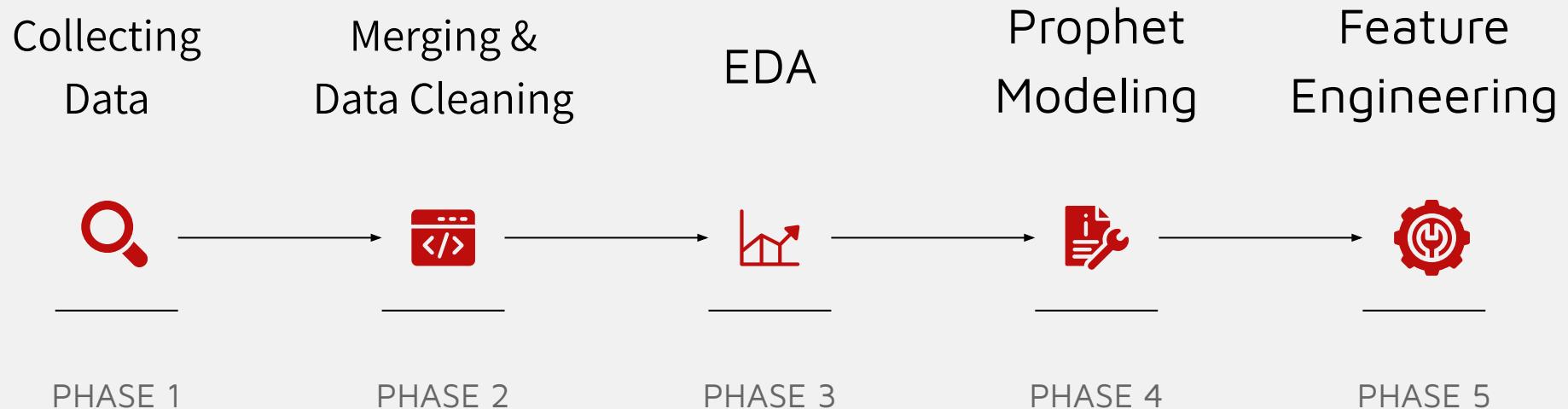


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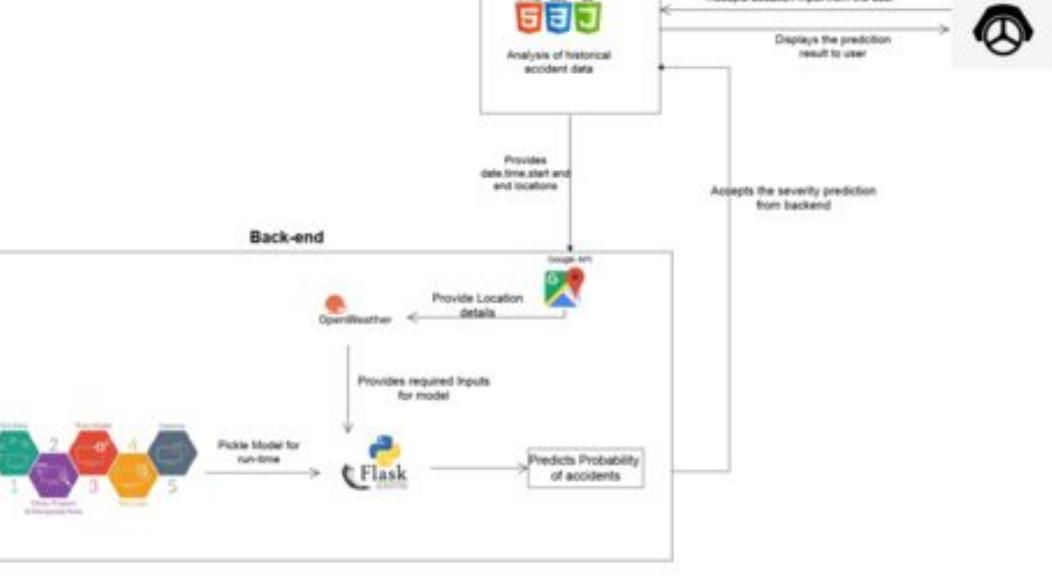
02 DATA SOURCES

03 EDA

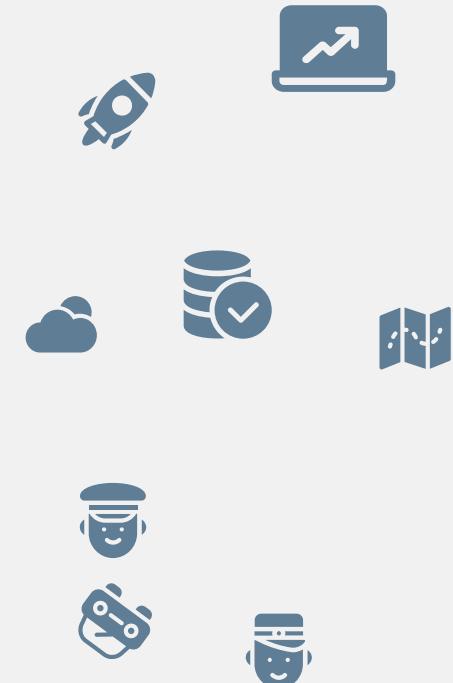
04 MODELING

05 EVALUATION

06 SUMMARY &
FUTURE WORK



AP





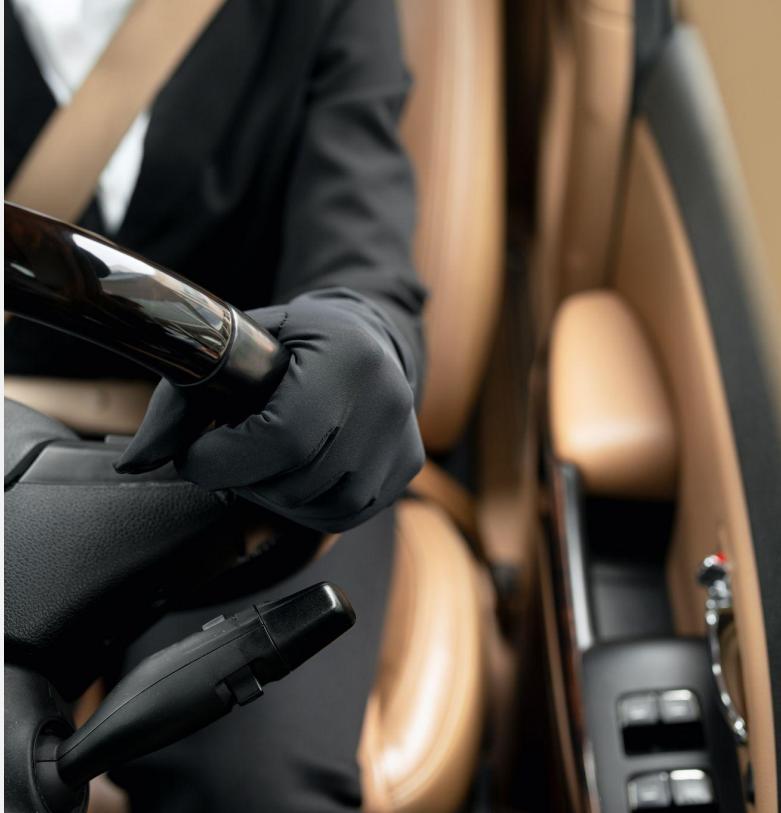


01



MOTIVATION & **PRODUCT**

Traffic Accidents Modeling



CONTENTS OF THIS **TEMPLATE**

This is a slide structure based on a marketing campaign presentation

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

FONTS To view this template correctly in PowerPoint, download and install the fonts we used

USED AND ALTERNATIVE RESOURCES An assortment of graphic resources that are suitable for use in this presentation

THANKS SLIDE You must keep it so that proper credits for our design are given

COLORS All the colors used in this presentation

ICON AND INFOGRAPHIC RESOURCES These can be used in the template, and their size and color can be edited

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OUR COMPANY

You can give here a brief description of the topic you want to talk about. For example, if you want to talk about Mercury, you can say that it's the smallest planet in the entire Solar System



OUR GOALS



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

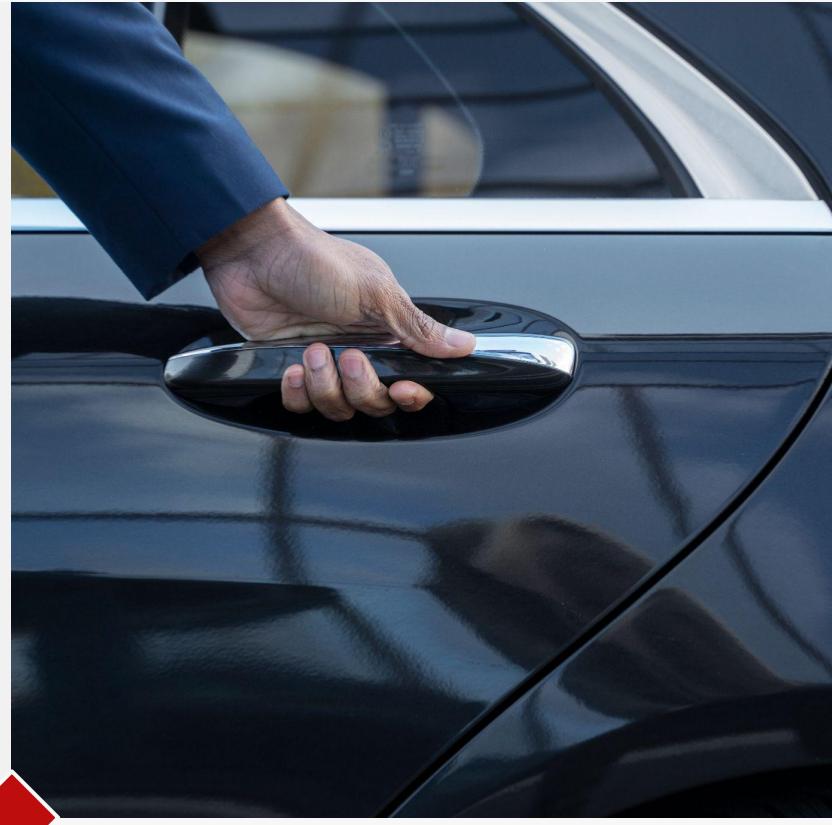


VENUS

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

TO REINFORCE THE CONCEPT, TRY USING AN **IMAGE**

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



MARKET **SHARE**

13%

● JUPITER

Jupiter is the biggest planet of them all

44%

● NEPTUNE

Neptune is very far away from the Sun

4%

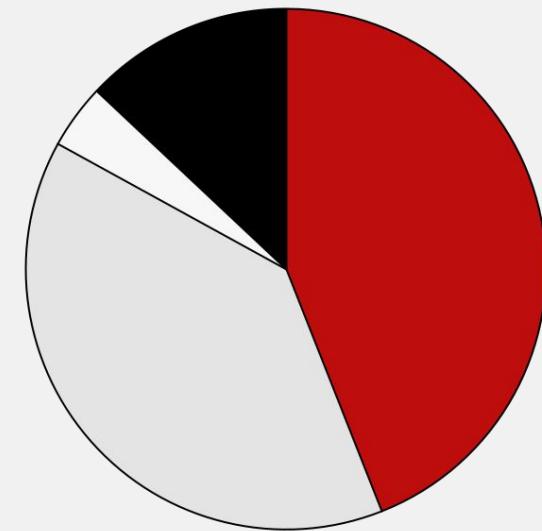
○ SATURN

Saturn is not the only planet with rings

39%

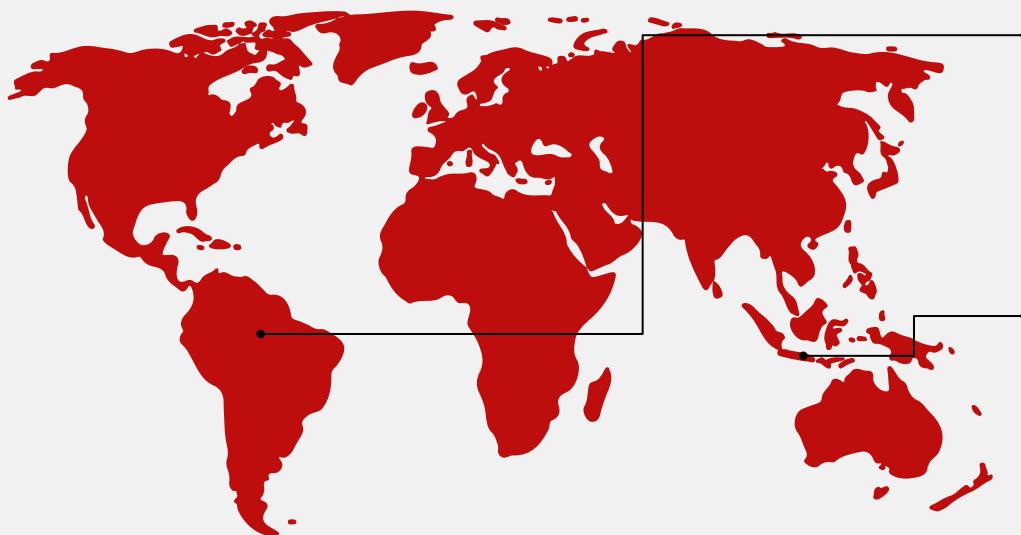
○ MERCURY

Mercury is the smallest planet of them all



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

LOCATIONS



MERCURY

It's the closest planet to the Sun and the smallest in the Solar System

MARS

It's full of iron oxide dust, which gives the planet its reddish cast



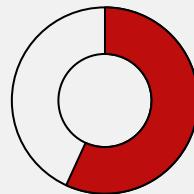


A PICTURE IS WORTH A
THOUSAND **WORDS**

CORE CUSTOMER AUDIENCE

THE SUPERIOR EXPERIENCE

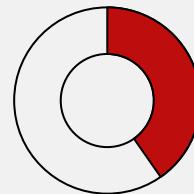
Mars



60%

Mars is full of iron oxide dust

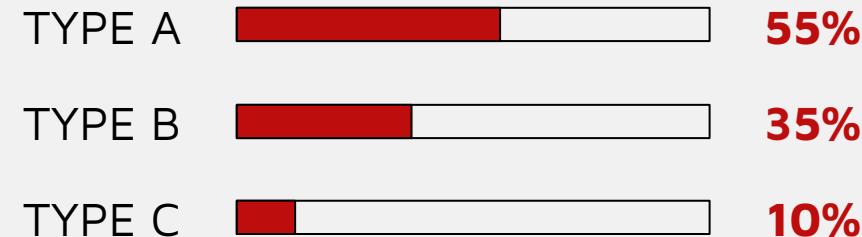
Saturn



40%

Saturn is the ringed planet

THE MOST CHARACTERISTIC



DESIRABLE FEATURES



Premium amenities



Customer experience



Innovative technology

COMPETITOR **ANALYSIS**



STRENGTHS

- ◆ You can list your competitor's strengths here
- ◆ You can list your competitor's strengths here
- ◆ You can list your competitor's strengths here

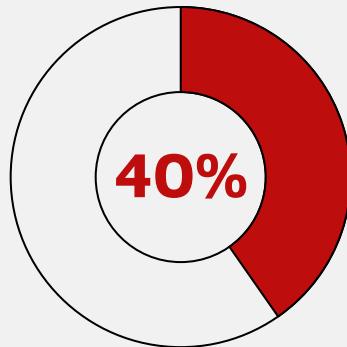


WEAKNESSES

- ◆ You can list your competitor's weaknesses here
- ◆ You can list your competitor's weaknesses here
- ◆ You can list your competitor's weaknesses here

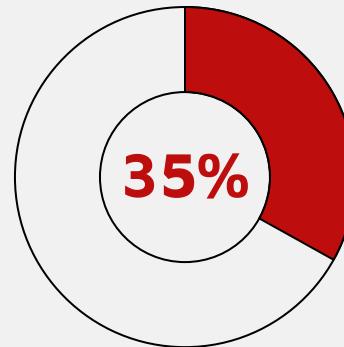


MARKET SEGMENTATION



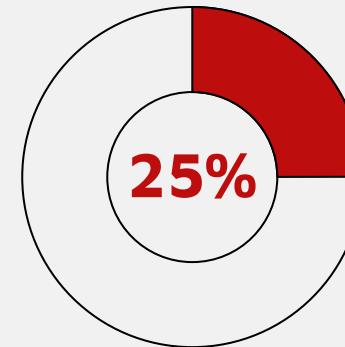
BABY BOOMERS

Mercury is the smallest planet of them all



MILLENNIALS

Venus is the second planet from the Sun



GEN XERS

Despite being red, Mars is actually a cold place

STRATEGY

STEP 1

Jupiter is the biggest planet
in the Solar System



STEP 2

Venus is the second planet
from the Sun

STEP 4

Saturn is a gas giant and
has several rings



STEP 3

Despite being red, Mars is a
very cold place



PRODUCT DESCRIPTION



EXTERIOR

- Write the product features here
- Write the product features here
- Write the product features here



INTERIOR

- Write the product features here
- Write the product features here
- Write the product features here



Solid



High-quality



Ergonomic



PRICING

BASIC



- ◆ Write the text here
- ◆ Write the text here
- ◆ Write the text here

\$1M

PRO



- ◆ Write the text here
- ◆ Write the text here
- ◆ Write the text here

\$8M

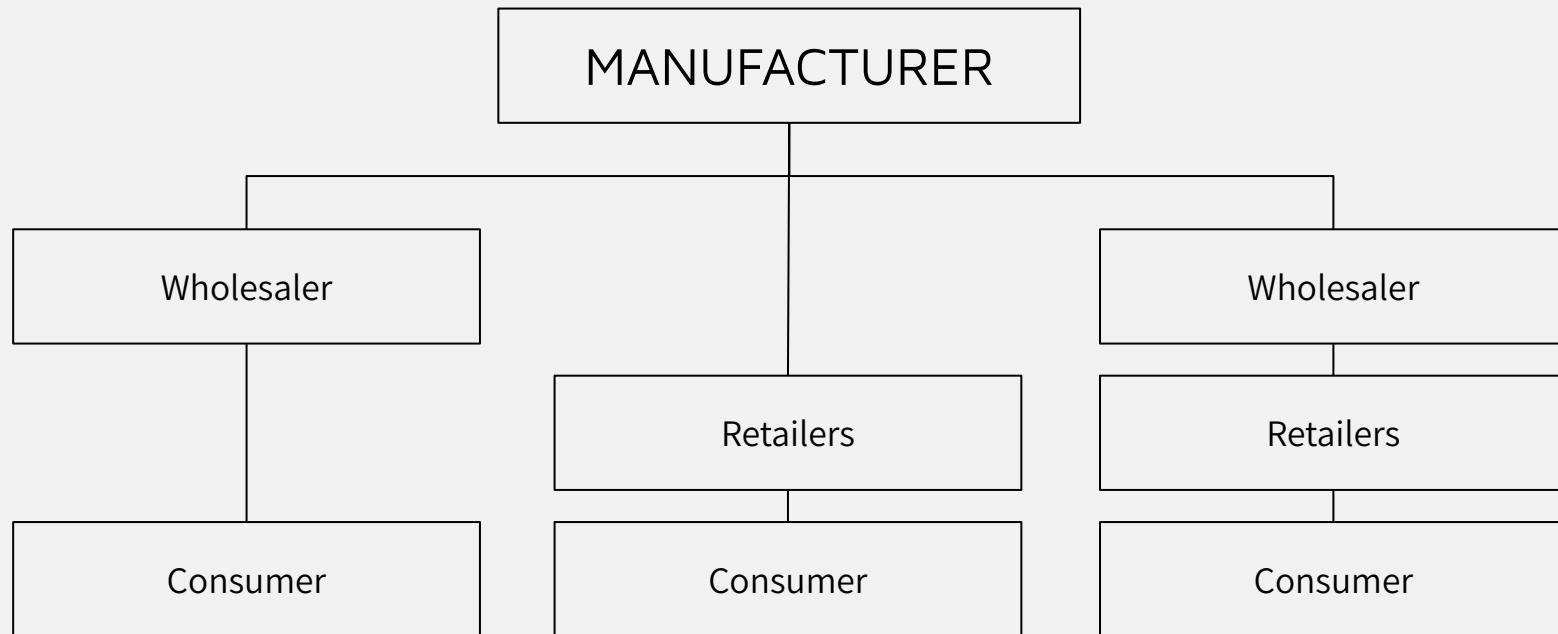
PREMIUM



- ◆ Write the text here
- ◆ Write the text here
- ◆ Write the text here

\$9M

DISTRIBUTION CHANNELS



MEDIA PROMOTION

MULTIMEDIA

Mercury is the closest planet to the Sun

PRESS

Venus is the second planet from the Sun

MOBILE APP

Mars is actually a very cold place

DIGITAL

Jupiter is the biggest planet of them all

PODCAST

Saturn is composed of hydrogen and helium

TELEVISION

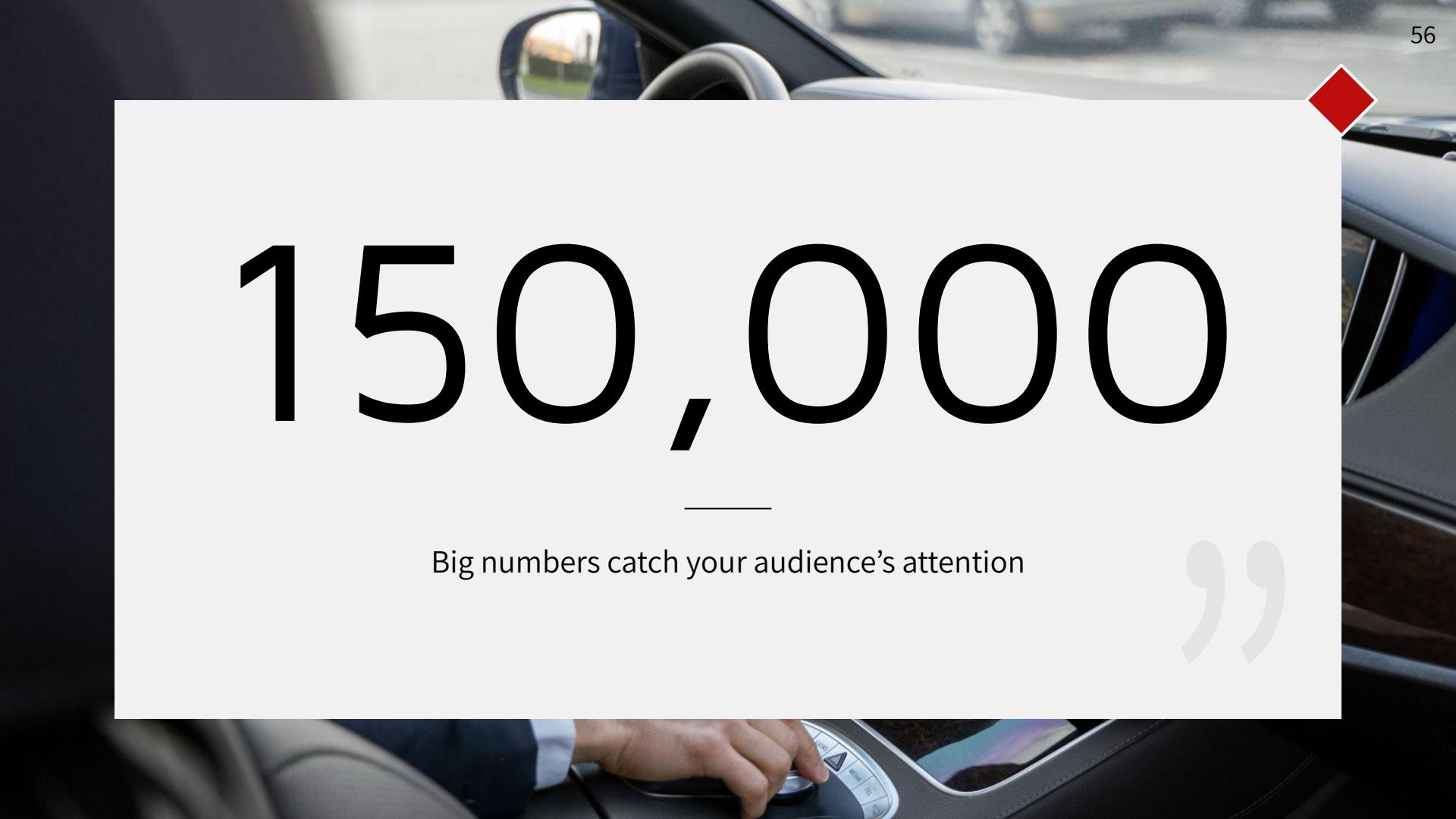
Neptune is the farthest planet from the Sun



150,000

Big numbers catch your audience's attention

“





9h 55m 23s

Jupiter's rotation period

333,000.000

The Sun's mass compared to Earth's

386,000 km

Distance between Earth and the Moon

ADVERTISING **CAMPAIGN 1**

ORGANIC MARKETING



BUDGET

\$15,000

GOALS

- ◆ You can list your goals here

DESCRIPTION

Venus has a beautiful name and is the second planet from the Sun. It's the second-brightest natural object in the night sky after the Moon

ADVERTISING **CAMPAIGN 2**

CHANNEL Billboards, television & radio

BUDGET **\$90,000**

GOALS

- ◆ You can list your goals here

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





PREDICTED REACH

+2,000

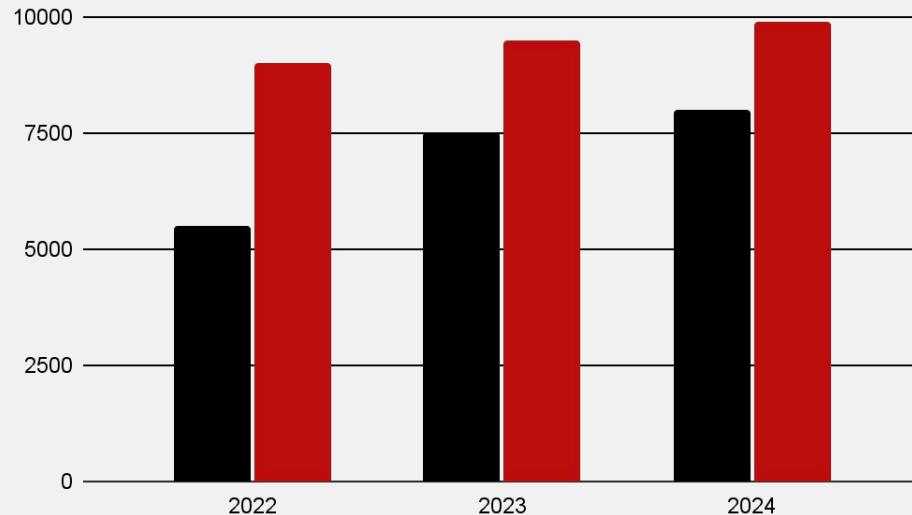
● JUPITER

Jupiter is the biggest planet of them all

+900

● SATURN

Saturn is a gas giant and has several rings



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

PR OUTREACH

MEDIA CHANNELS



SOCIAL MEDIA

Mercury is the smallest planet in the Solar System



TELEVISION

Despite being red, Mars is actually a cold place



PRINT MEDIA

Neptune is the fourth-largest planet in the Solar System

KEY MESSAGES

1

“Venus is extremely hot, even more than Mercury”

2

“Earth is the third planet from the Sun and harbors life”

MAIN GOALS

Jupiter



57%

Saturn



80%



BUDGET **ALLOCATION**

ITEMS	QTY.	PRICE	TOTAL
Venus	10	\$200K	\$2M
Mars	90	\$100K	\$9M
Jupiter	80	\$200K	\$16M
Saturn	50	\$300K	\$15M
Neptune	40	\$200K	\$8M

OUR TEAM



You can speak a bit about
this person here

JENNA DOE



You can speak a bit about
this person here

TIMMY JIMMY



You can speak a bit about
this person here

BILLY BONES





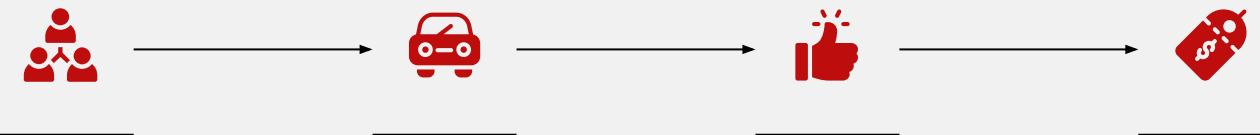
TIMELINE

PHASE 1

PHASE 2

PHASE 3

PHASE 4



NEPTUNE

It's the farthest
planet from the Sun

MERCURY

It's the closest
planet to the Sun

VENUS

It's the second
planet from the Sun

JUPITER

It's the biggest
planet of them all



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You can replace the image on the screen with your own work. Right-click on it and then choose "Replace image"



THANKS!

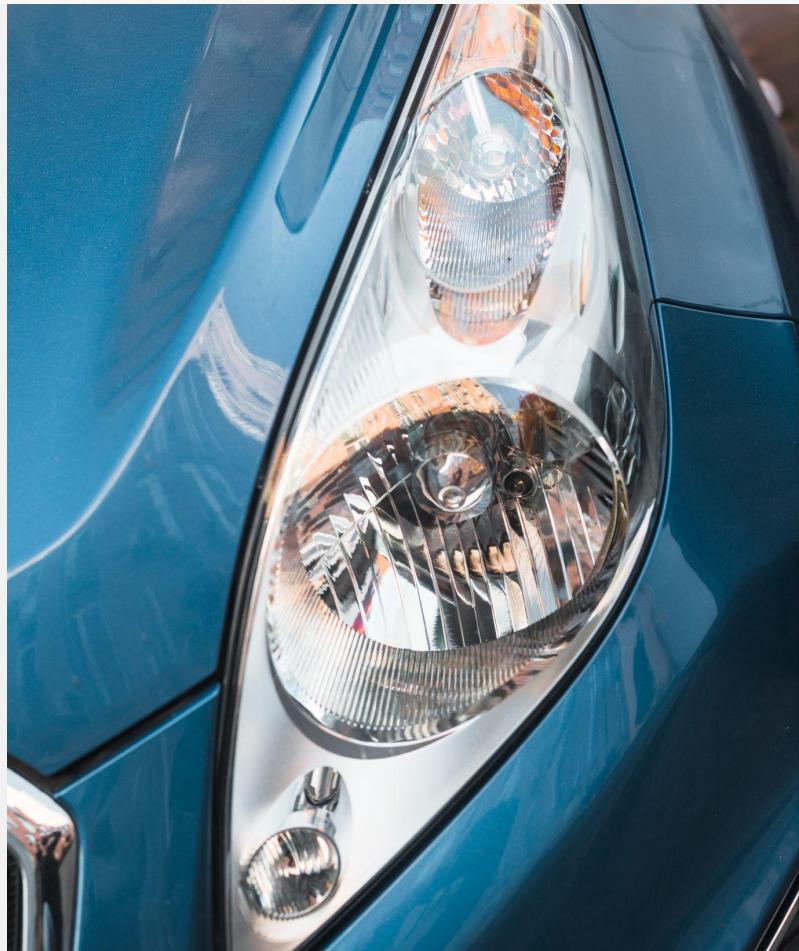
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- ◆ Medium shot black car lights
- ◆ Medium shot car back lights
- ◆ Detail red sport car I
- ◆ Detail red sport car II
- ◆ Front view black car lights
- ◆ Medium shot car back lights
- ◆ Auto steering wheel light switch control paddle
- ◆ Back dark car with red rear light
- ◆ Close up gear shifter from modern car
- ◆ Side view young man riding car
- ◆ Stylish led headlight white automobile



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PHOTOS

- ◆ Close up on car care process
- ◆ Female taxi driver paying attention to the road
- ◆ Sideways rear-view mirror of a modern car
- ◆ Elegant uber driver giving taxi ride I
- ◆ Elegant uber driver giving taxi ride II
- ◆ Elegant uber driver giving taxi ride III
- ◆ Elegant uber driver giving taxi ride IV
- ◆ Stylish headlight of white car
- ◆ Driver dressed in elegant costume
- ◆ Team meeting online conference call
- ◆ Led headlight of blue car
- ◆ Driver dressed in elegant costume
- ◆ Man using his car's options while driving
- ◆ Elegant uber driver giving taxi ride
- ◆ Driver dressed in elegant costume

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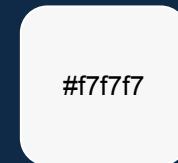
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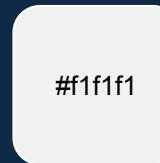
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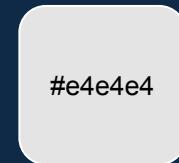
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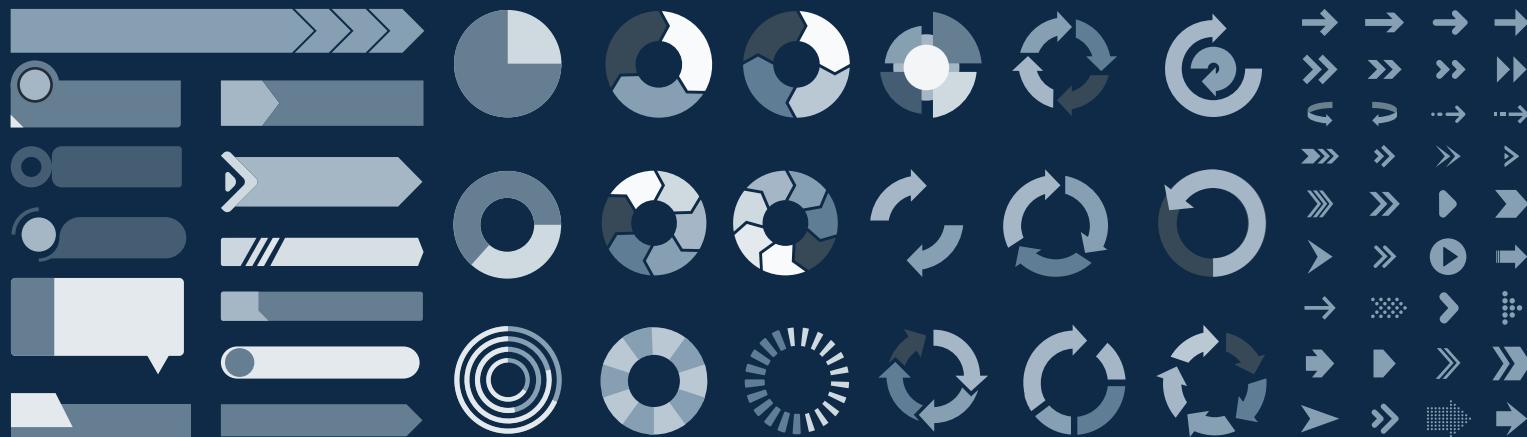
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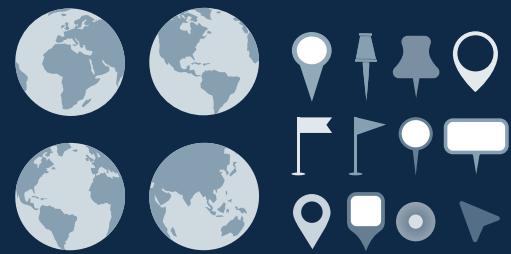


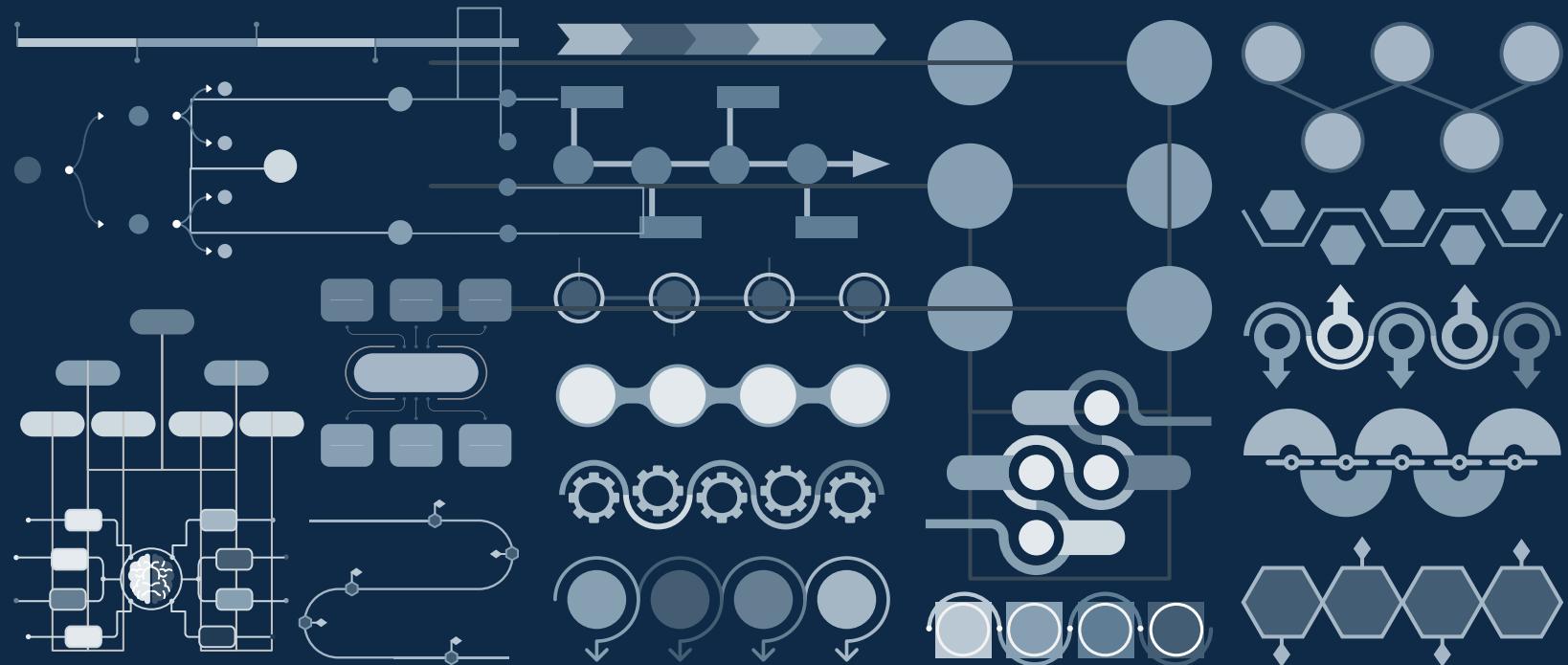
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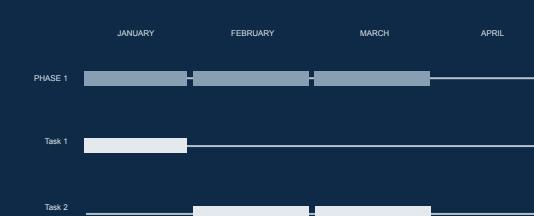
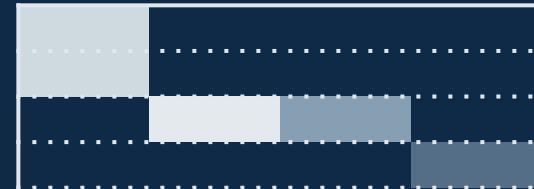
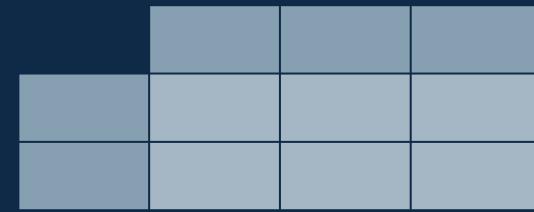
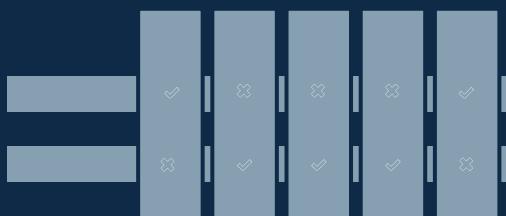
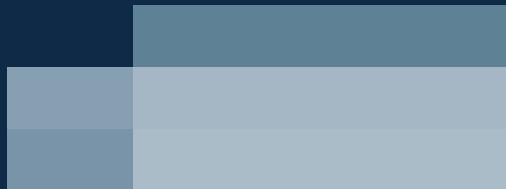
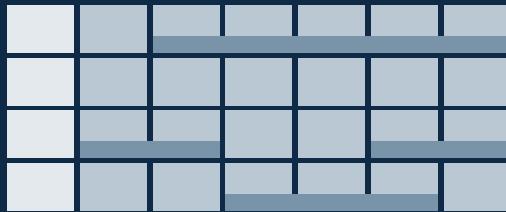
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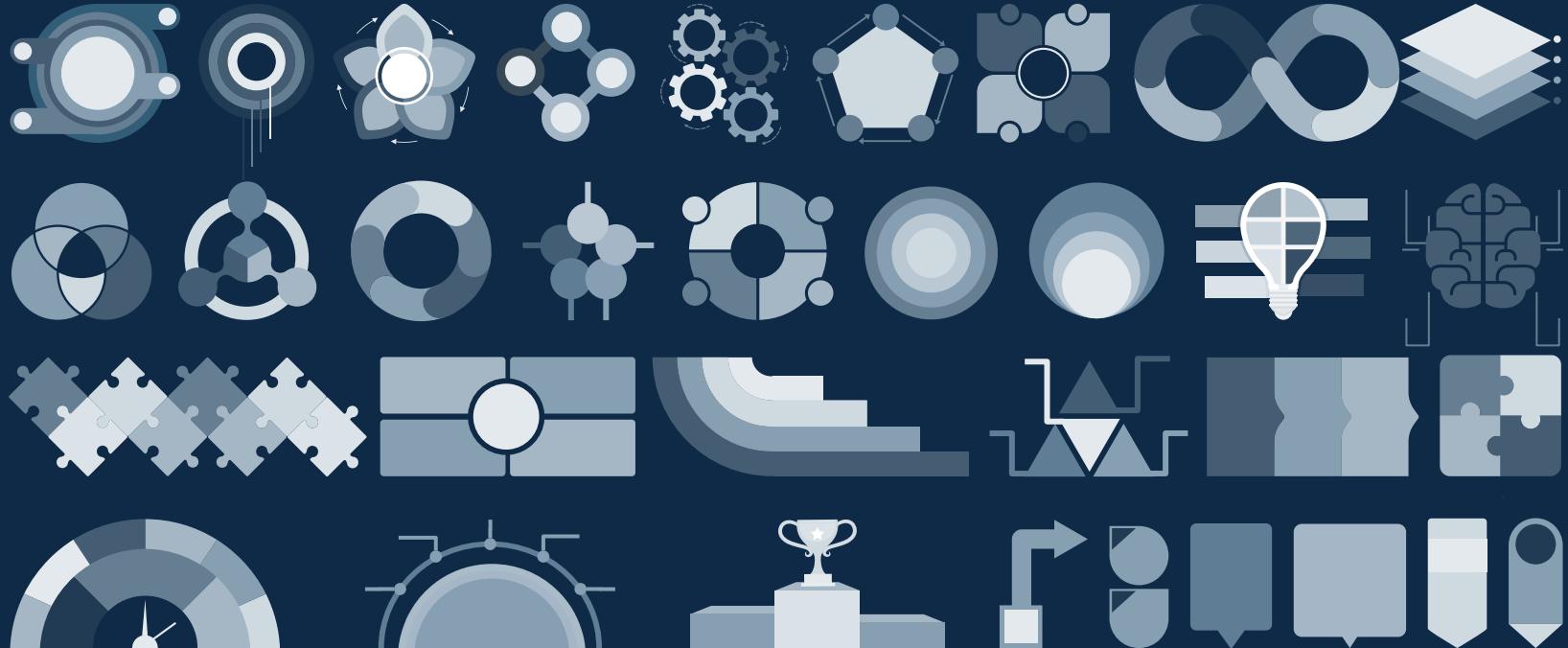
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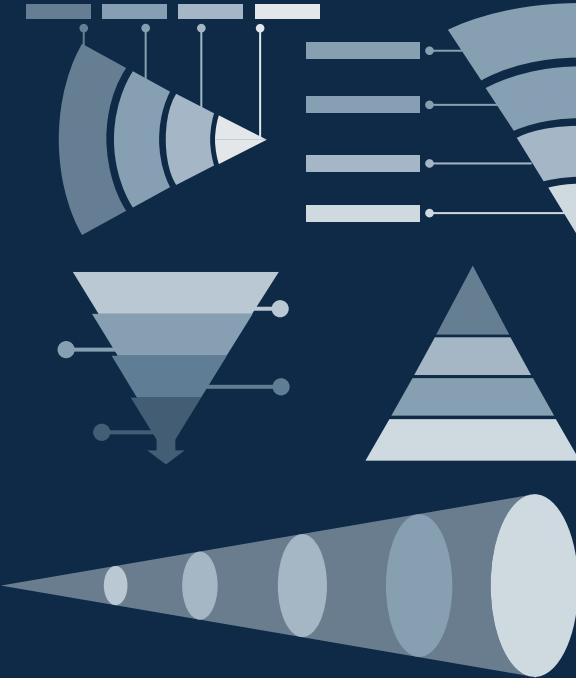
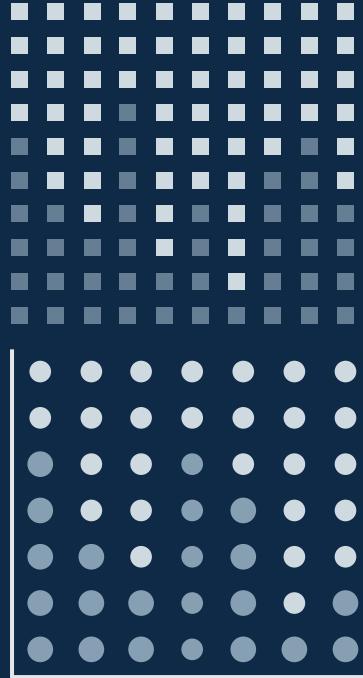












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