



# AI, GenAI & Agentic AI for Automotive Leaders and Developers

Surendra Panpaliya

# Generative AI

Gen-AI

# Day 1



**AI/ML/DL – Foundation for Automotive Innovation**



**Objective**



Provide leaders



Understanding of AI, ML, DL



Applications in automotive.

# Day 1



What is AI, ML, DL



Definitions and Differences



Use of AI in Automotive



Safety, Maintenance, Manufacturing



Python Libraries Overview

# Day 1



**Use Case:** Predictive Maintenance using sensor data



**Demo:** Build a basic model that predicts EV motor failure



**Case Study:** AI Use in Tesla, BMW, Toyota



**Demo Focus:** How AI predicts problems before they happen

# Use of AI in Automotive



**Key Areas & Examples**



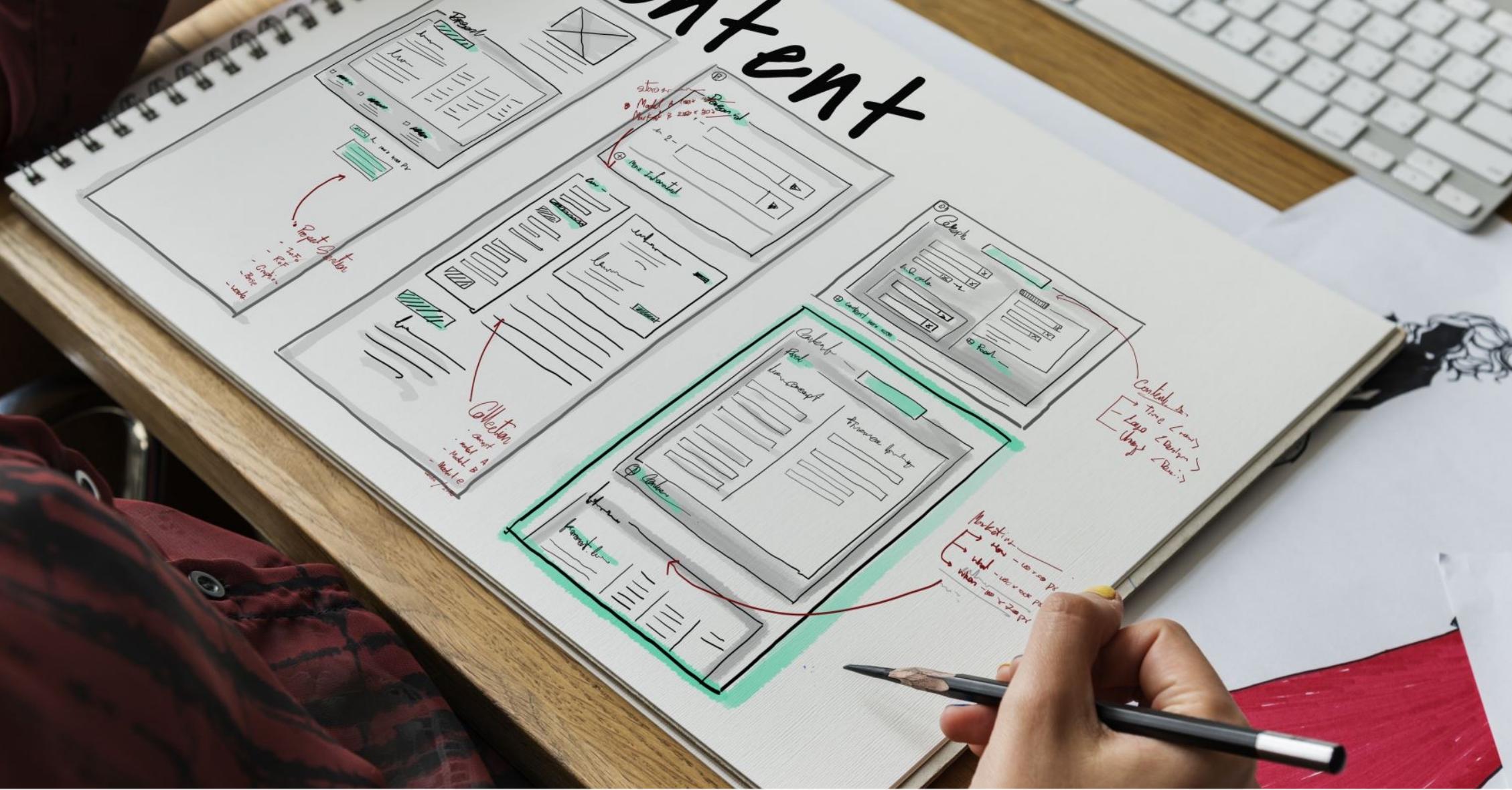
Safety, Maintenance,  
Manufacturing

## **1. Safety**

Enhance driver and passenger safety

through real-time monitoring,

assistance, and autonomous decision-making.



# Applications & Examples

Surendra Panpaliya

# **ADAS (Advanced Driver Assistance Systems)**

Uses AI to detect lane departures,  
assist in lane keeping,  
automatic braking, and  
adaptive cruise control.

# **ADAS** **(Advanced** **Driver** **Assistance** **Systems)**



*Example*



*Tesla Autopilot,*



*Mercedes-Benz Drive Pilot*

# Driver Monitoring System (DMS)



AI-powered cameras monitor driver's eyes,



head movement, and attention levels



to detect drowsiness or distraction.

# **Driver Monitoring System (DMS)**

*Example*

*Toyota's Guardian  
System*

*Volvo's Driver Alert  
Control*

# Collision Avoidance



AI analyzes data from radar, cameras, and



LiDAR to prevent accidents



by taking proactive actions.



*Example: Subaru EyeSight*



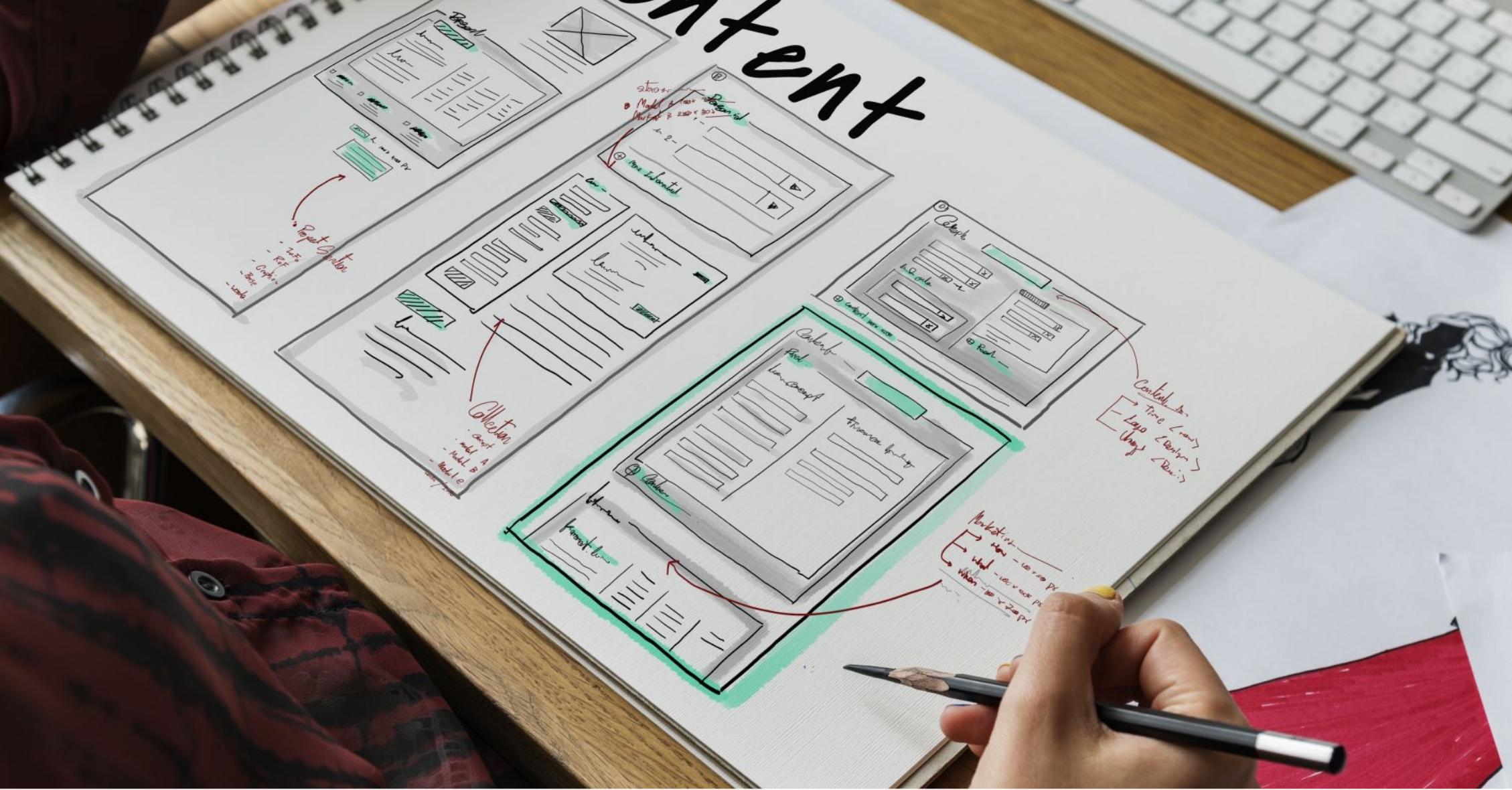
## 2. **Maintenance**

Predict failures,

reduce downtime, and

improve vehicle reliability

using AI-based diagnostics.



# Applications & Examples

Surendra Panpaliya

# Predictive Maintenance



AI analyzes sensor data



(e.g., vibrations, temperature, oil condition)



to forecast component failures



before they occur.

# Predictive Maintenance



*Example:*



*BMW's AI platform*



*that predicts battery wear*



*in electric vehicles*

# Remote Diagnostics



AI-enabled connected vehicles



can self-diagnose issues and



share reports with service centers in real-time.



*Example: General Motors'*



*OnStar Vehicle Insights*

# Digital Twin for Vehicles



CREATING A VIRTUAL  
MODEL OF A VEHICLE



TO MONITOR ITS  
PERFORMANCE



AND PREDICT ISSUES.

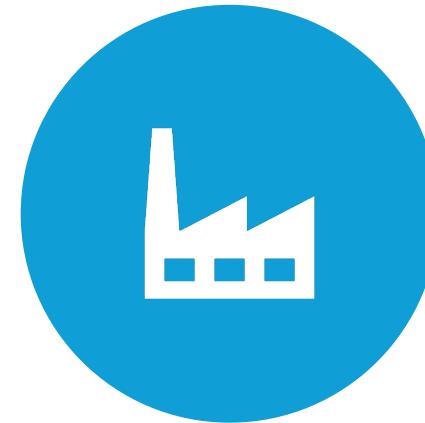
# Digital Twin for Vehicles



EXAMPLE:



AUDI USES AI DIGITAL  
TWINS



IN FACTORY TEST LINES

# 3. Manufacturing



Improve productivity,



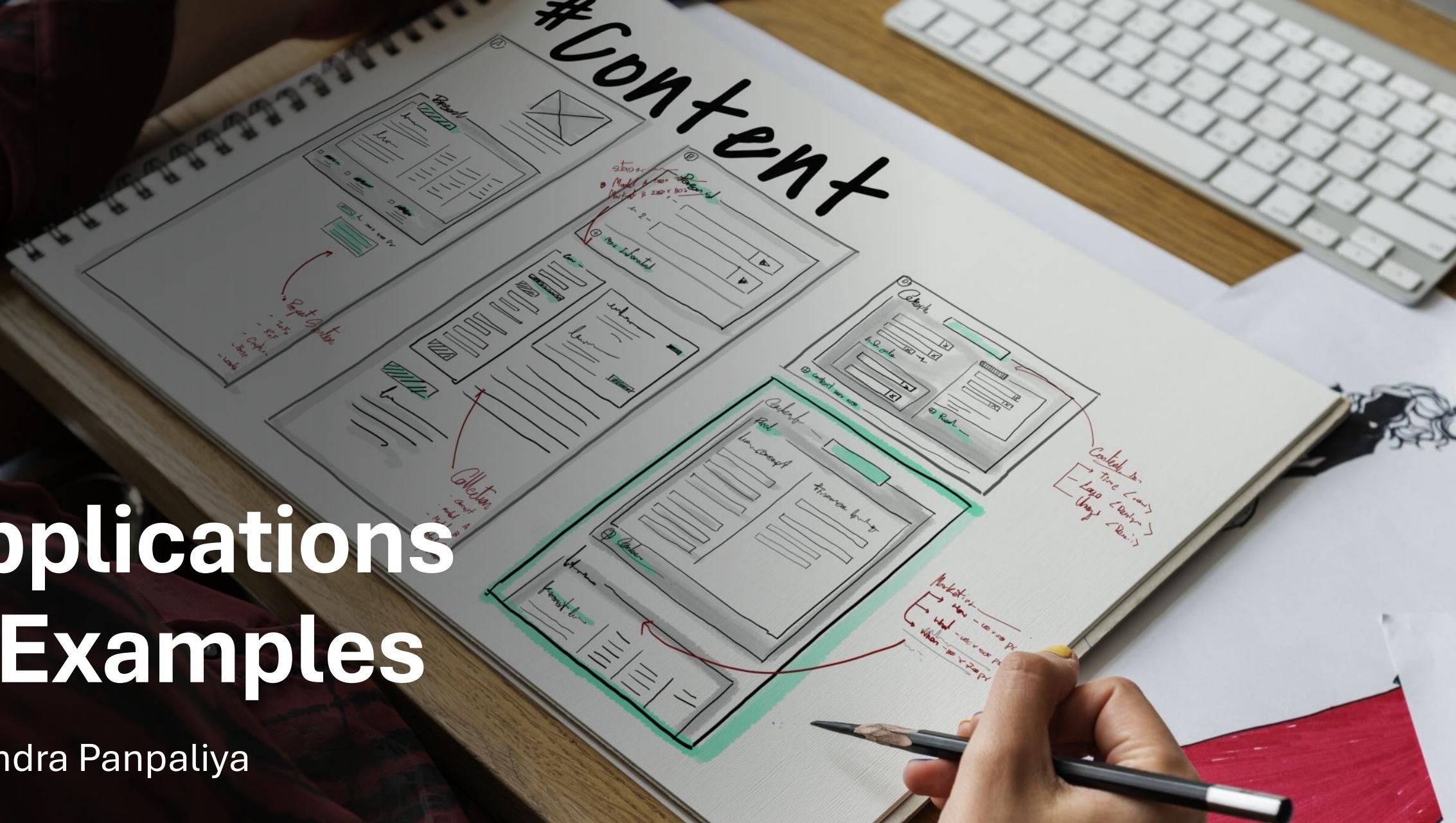
precision, and quality



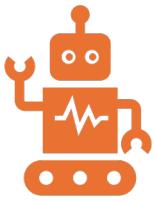
across automotive  
manufacturing processes.

# Applications & Examples

Surendra Panpaliya



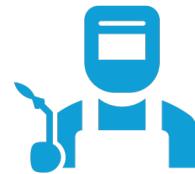
# AI-Powered Robotics in Assembly



Robots equipped  
with AI



perform complex  
tasks like



welding,  
painting, and



assembling with  
minimal errors.

# AI-Powered Robotics in Assembly



EXAMPLE



BMW'S AI-ASSISTED



ROBOTIC ARMS IN  
BODY SHOP

# Quality Control with Computer Vision

AI inspects products

for surface defects,

incorrect fits, and

paint inconsistencies

using image recognition.

# Quality Control with Computer Vision



EXAMPLE:



TOYOTA USES AI VISION



TO INSPECT EACH CAR'S  
FINISH IN SECONDS

# Supply Chain Optimization



AI forecasts demand, optimizes logistics



manages inventory in real-time.



Example



Volkswagen's AI-based supply chain dashboard



# Summary Table

Area	AI Use Case	Example
Safety	ADAS, Driver Monitoring	Tesla Autopilot, Toyota Guardian
Maintenance	Predictive Diagnostics, Digital Twins	BMW, GM OnStar, Audi
Manufacturing	Smart Robotics, Visual QC, Supply Chain	BMW, Toyota, Volkswagen



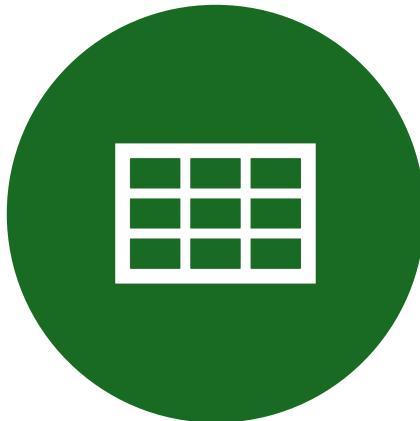
# Python Libraries Overview for Automotive AI & Analytics

Surendra Panpaliya

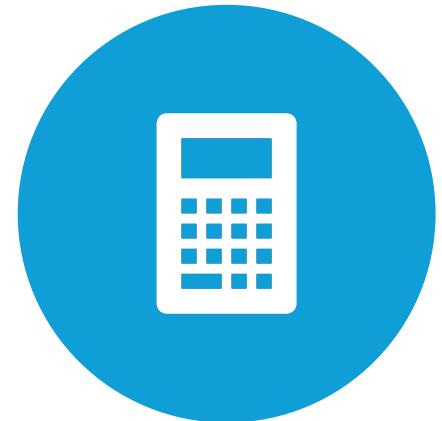
# 1. NumPy (Numerical Python)



FAST, EFFICIENT  
HANDLING

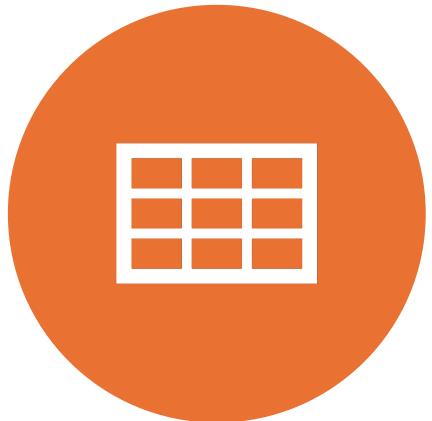


OF LARGE NUMERICAL  
ARRAYS AND



MATHEMATICAL  
OPERATIONS.

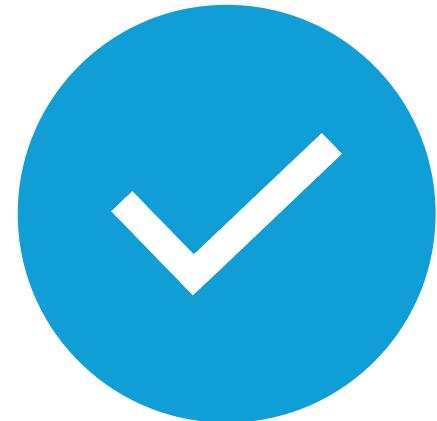
# NumPy Key Features



MULTI-DIMENSIONAL ARRAYS  
(NDARRAY)



LINEAR ALGEBRA, FOURIER  
TRANSFORM, STATISTICAL  
OPERATIONS



EFFICIENT PERFORMANCE (C-  
BASED BACKEND)



# Automotive Example

## Sensor Signal Processing:

Handle raw LiDAR, RADAR, or

accelerometer data from vehicle sensors.

*Use NumPy arrays to clean,*

*normalize, and process vehicle telemetry data.*



# Code Snippet



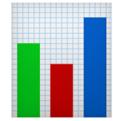
```
import numpy as np
```



```
speed_data = np.array([60, 62, 65,  
67, 70])
```



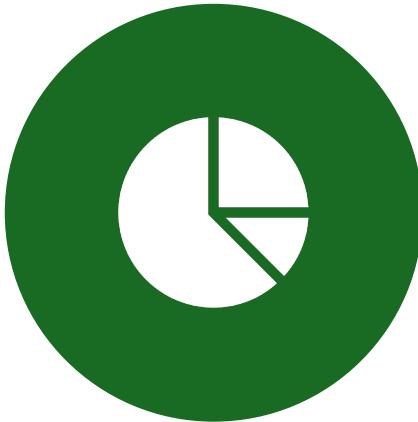
```
average_speed =  
np.mean(speed_data)
```



## 2. Pandas



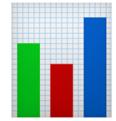
ANALYZE AND  
MANIPULATE



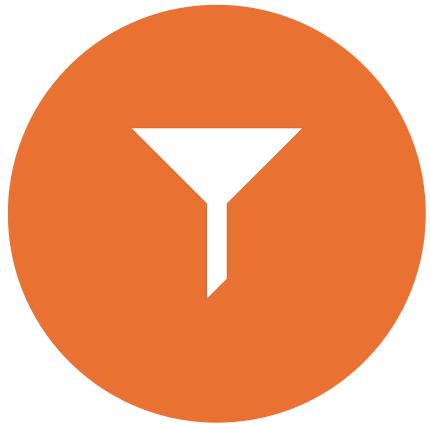
TABULAR DATA WITH  
DATAFRAMES



(LIKE EXCEL SHEETS  
BUT SMARTER).



## 2. Pandas Key Features:



DATA CLEANING,  
FILTERING, GROUPING



TIME-SERIES  
HANDLING



INTEGRATION WITH  
CSV/EXCEL/SQL FILES



# Automotive Example



## Fleet Data Analysis:



Analyze vehicle usage data,



fuel consumption, or



engine performance across a fleet.



*Detect usage patterns or*



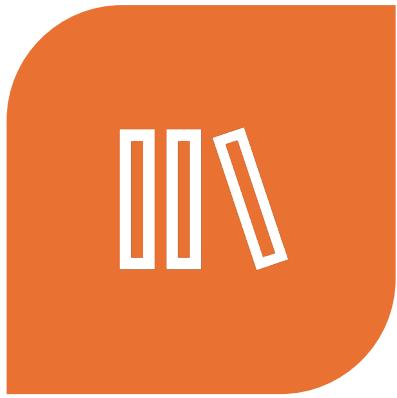
*anomalies in real-time using DataFrames.*

# Pandas Code Snippet

```
import pandas as pd  
df = pd.read_csv('vehicle_data.csv')  
print(df.groupby('vehicle_type')['fuel_efficiency'].mean())
```



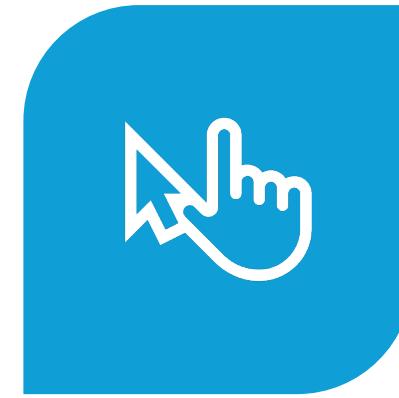
## 3. Matplotlib



BASIC DATA  
**VISUALIZATION** LIBRARY



FOR CREATING STATIC,



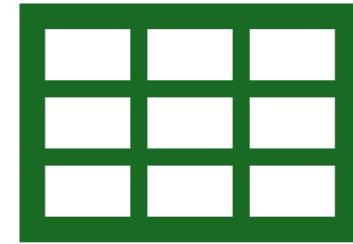
ANIMATED, AND  
INTERACTIVE PLOTS.



## 3. Matplotlib Key Features



Line, bar, pie charts,  
histograms



Customization of plots (labels,  
grids, titles)

# Automotive Example



**Plot Fuel Consumption Trends:**



Show how fuel usage varies over time or by driver.

# Matplotlib

```
import matplotlib.pyplot as plt  
plt.plot(df['date'], df['fuel_efficiency'])  
plt.title('Fuel Efficiency Over Time')  
plt.xlabel('Date')  
plt.ylabel('Efficiency (km/l)')  
plt.grid(True)  
plt.show()
```



## 4. Seaborn

High-level statistical  
visualization

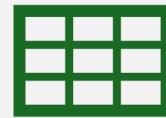
built on top of  
Matplotlib.



## 4. Seaborn Key Features



Beautiful default themes



Heatmaps, box plots, regression plots



Works well with Pandas  
DataFrames



# Automotive Example



## Correlation Heatmap:



Show how speed, acceleration, and



braking frequency are related.



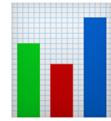
*Useful in developing AI driving models or*



*evaluating driver behavior.*

# Seaborn Code Snippet

```
import seaborn as sns  
sns.heatmap(df.corr(), annot=True, cmap='coolwarm')
```



# Summary Table

Library	Purpose	Automotive Application Example
NumPy	Fast numerical computation	Process vehicle sensor data
Pandas	Data manipulation & analysis	Analyze fleet vehicle usage or service history
Matplotlib	Visualization (basic)	Plot trends like mileage, speed over time
Seaborn	Statistical visualization	Analyze feature correlations (e.g., braking vs speed)

# Visual Use Case: Predictive Maintenance

- **NumPy** → Clean sensor data from engine temperature
- **Pandas** → Aggregate and filter data by vehicle ID
- **Matplotlib** → Plot heat vs wear over time
- **Seaborn** → Correlate temperature, age, and maintenance frequency



# Case Study: AI Use in Tesla, BMW, and Toyota

Surendra Panpaliya

# Tesla – AI for Autonomous Driving and OTA Intelligence

The car of the future is  
not just electric

it's intelligent.

Elon Musk

# AI Focus Areas

**Autopilot & Full Self-Driving (FSD):**

Tesla uses **neural networks**

to process video from 8 external cameras  
and

12 sensors to perform lane-keeping,

overtaking, and traffic sign recognition.

# AI Focus Areas



**Dojo Supercomputer:**



Built to train AI models at scale



using millions of driving hours.

# AI Focus Areas

**Over-the-Air (OTA) Updates**

Tesla pushes AI improvements and  
driving features regularly

based on real-world fleet data.

# AI Focus Areas



## AI-Powered User Personalization



Adjusts seat, music,



route preferences automatically.

# Results



97% of Tesla's software features



are improved remotely



via AI-led data analytics.

# Results



Tesla's AI has reduced



the number of accidents by 40%



in assisted-driving mode



(Source: Tesla Impact Report).

# AI Tools Used

PyTorch,

NVIDIA GPU  
stack,

Dojo,

Edge computing  
with inference  
models

# BMW – AI for Manufacturing and Predictive Maintenance



# AI Focus Areas



**Smart Factory (Industry 4.0):**



BMW uses **computer vision AI**



to check thousands of parts per minute



for quality assurance.

# AI Focus Areas



## Predictive Maintenance:



AI sensors in BMW cars



predict component failures



(e.g., brake pads, battery)



before they happen.

## AI Focus Areas



**Robotic Process Automation  
(RPA)**



AI bots manage logistics and



supply chain decisions in real-time.

# AI Focus Areas

**Driver Experience Optimization:**

Analyzes driver behavior

to adjust drive modes, music, and

climate control dynamically.

# Results



Improved **production efficiency** by 30%



in Munich plant using AI vision systems.



Prevented ~25% unplanned downtime



with predictive AI on EVs.

## AI Tools Used

AWS AI Services,

TensorFlow,

Microsoft Azure AI,

custom CNNs for visual inspection

# Toyota – AI for Safety, Robotics, and Smart Mobility

Surendra Panpaliya



# AI Focus Areas



## Guardian AI System:

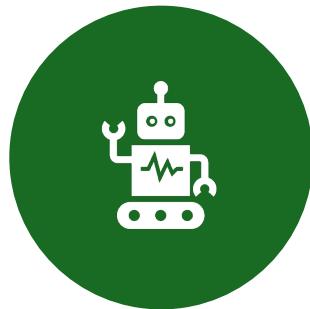


Works in the background to assist human drivers (rather than replace them) with auto-correction, lane control, and accident prevention.

# AI Focus Areas



**TOYOTA RESEARCH  
INSTITUTE (TRI):**



LEADS INNOVATION  
IN ROBOTICS,



REINFORCEMENT  
LEARNING, AND



MATERIAL  
DISCOVERY.

# AI Focus Areas



**SMART MOBILITY  
ECOSYSTEM:**



**AI HELPS TOYOTA  
BUILD**



**CONNECTED VEHICLE  
ECOSYSTEMS**



**USING TELEMATICS +  
BEHAVIORAL AI.**

# AI Focus Areas



## Emotion-Sensing Vehicles:



AI interprets driver emotion

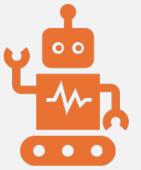


from facial recognition and



adjusts in-vehicle ambiance accordingly.

# Results



Guardian AI has reduced driver error impact in 80%+ of trials.



TRI is contributing to next-gen materials and



battery chemistry using AI simulations.

# AI Tools Used

NVIDIA Drive,

ROS (Robot Operating System),

reinforcement learning models,

Toyota AI Ventures investments

# Summary Table

Company	Key AI Focus	Business Impact
Tesla	Self-driving, OTA AI, personalization	Fewer accidents, faster innovation cycles
BMW	Smart factory, predictive maintenance	Better quality, reduced downtime
Toyota	Safety AI (Guardian), smart mobility	Increased safety, human-centric autonomy

Happy Learning!!  
Thanks for Your  
Patience 😊

Surendra Panpaliya  
GKTCS Innovations

