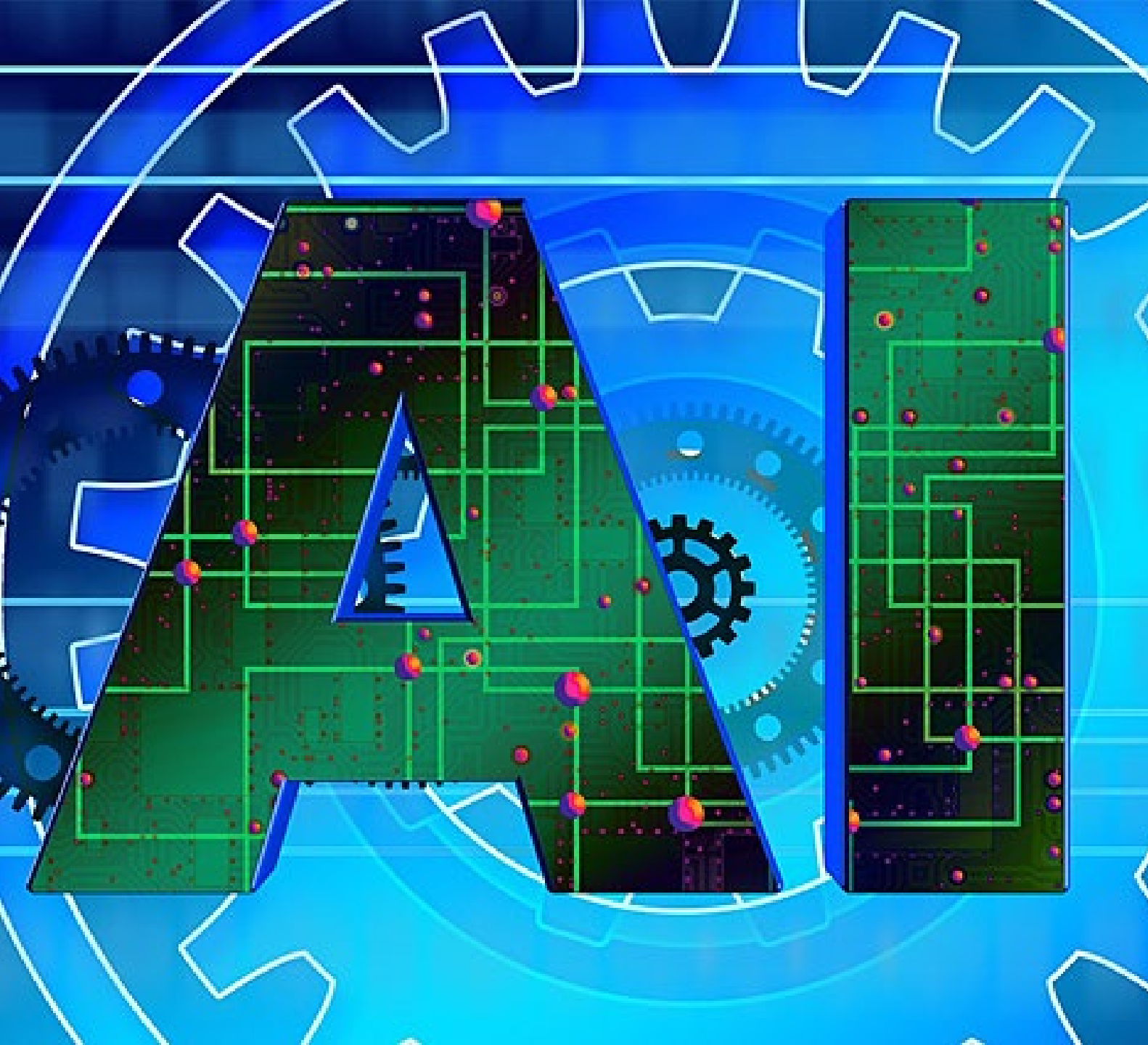
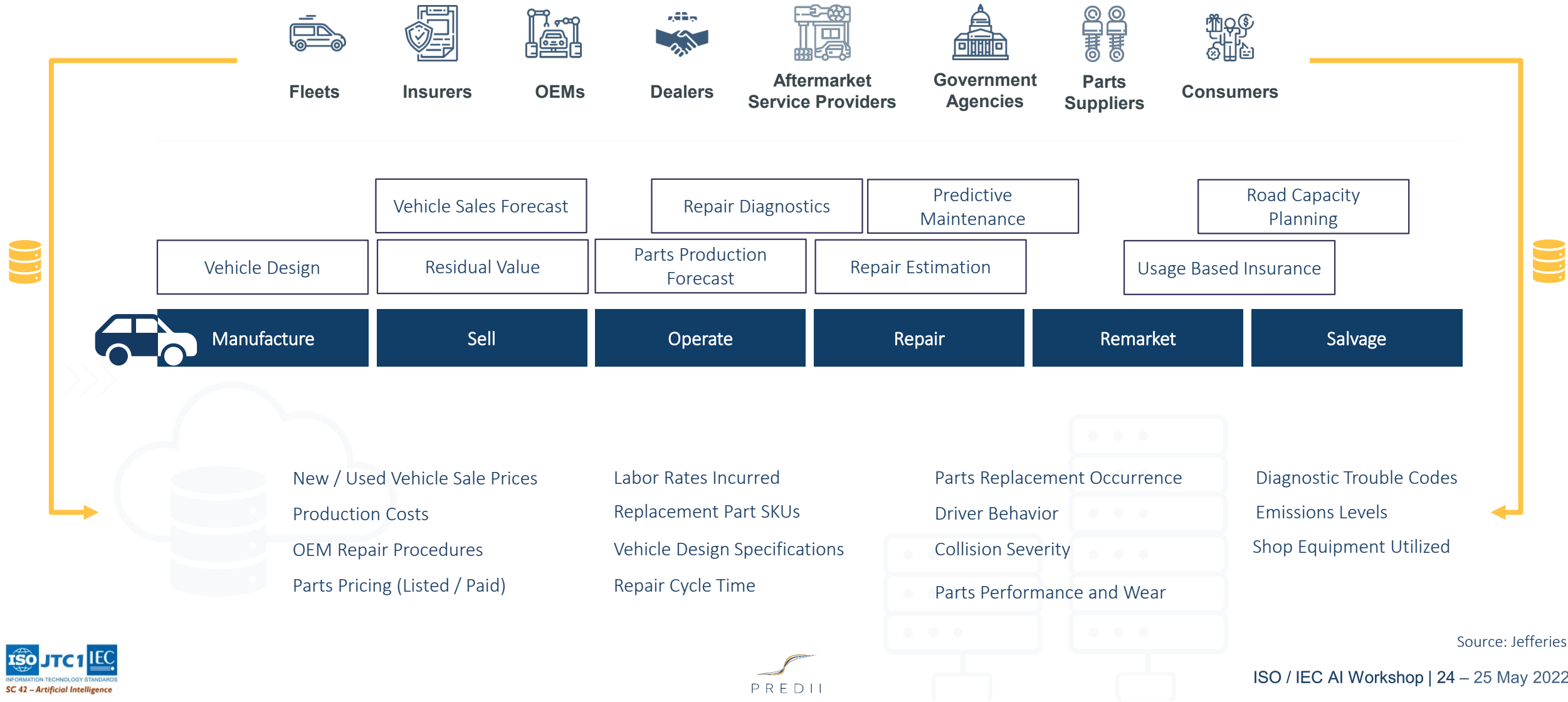




How specialized AI drives value for Automotive Service Organizations

Tilak Kasturi

Automotive Ecosystem Use Cases



Automotive Data is unstructured, complex.



\$2 Trillion total global market
2% of US nominal GDP
4.7 Million jobs in the US



~1.4 Billion vehicles in operation globally
12.2 Years average age of light vehicles (US cars & light trucks)
100K make, model, engine, transmission combinations

Automotive service focus is to minimize breakdowns



Predict and Prescribe

Right Part, right place, right time

Challenges with Automotive service data for AI Applications



- Availability of data for research community
- Proprietary and heterogeneous data
- Large NLP models are not trained on “automotive data”
- Data is too noisy
 - Textual data has industry and local acronyms, incomplete sentence structures, etc.
 - Connected car data is not continuous, lacks coverage

State-of-the-art NLP Trends



- Transformers changed the landscape and is here to stay
- Thrust on low-resource languages; multi-lingual NLP going mainstream
- Breaking barriers: Supervised --> Unsupervised --> Self-supervised learning (hybridization)
- Low-code NLP on the rise
- Multimodal systems gaining momentum

Advancements in developing large NLP Models

- BERT started the trend towards dynamic models
- Race towards larger NLP models
- Megatron-Turing NLG model at 530B parameters!
- Powering downstream tasks
 - Semantic search
 - Automated dialogue generation
 - Summarization
 - machine translation
 - Commonsense reasoning

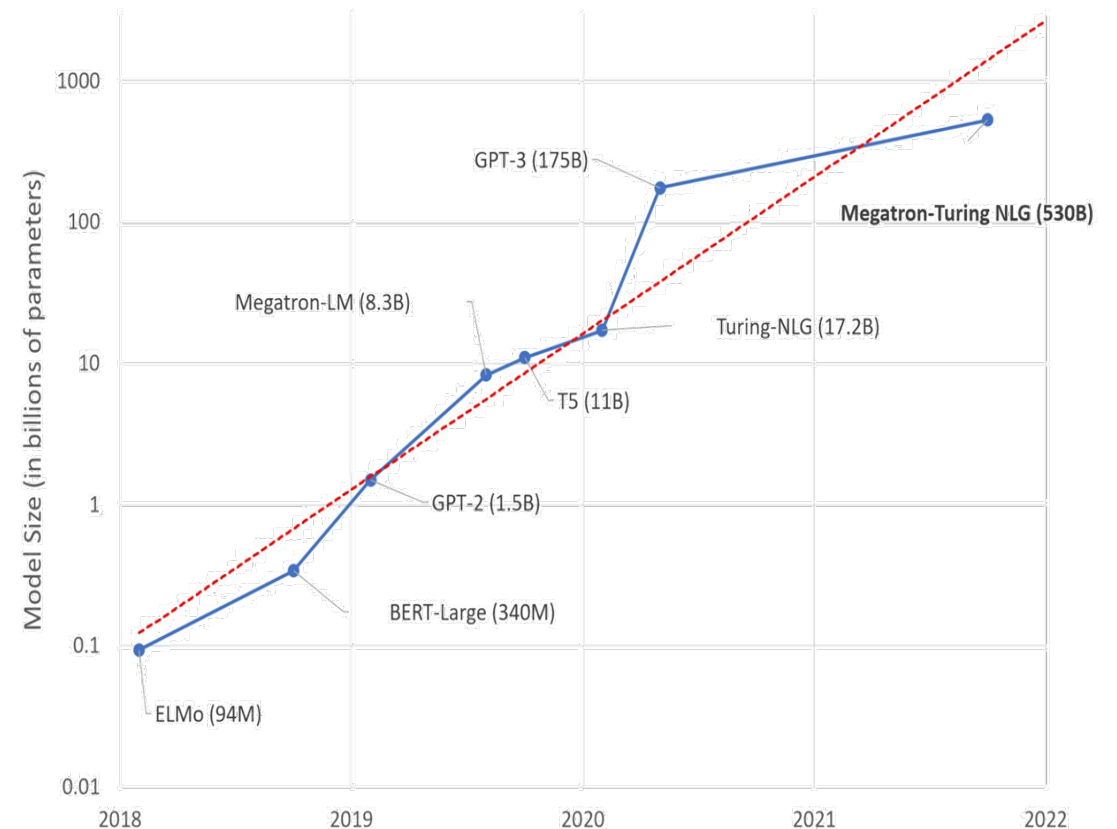


Figure 1. Trend of sizes of state-of-the-art NLP models over time

Source: Using DeepSpeed and Megatron to Train Megatron-Turing NLG 530B, the World's Largest and Most Powerful Generative Language Model - Microsoft Research

Large Language Models are not meant for industry specific use-cases



Models should drive specific decisions

When will breakdowns happen and why?

Which repair will resolve the issue?

Which issues are a safety concern?



Models need to be explainable

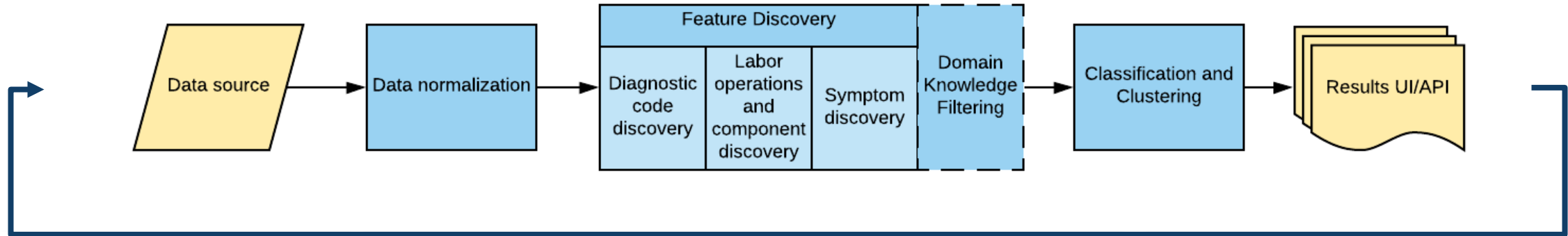


Models should have high confidence



Models need 'deep contextual understanding' in **specialized domain**

MLOps & Cloud native AI Pipeline drive actionable decisions



Odometer 90,062 / 2019 / BMW X3

RO Lines

18221 : Part - **THROTTLE BODY**

18219 : Part - **Oil**

18220 : Part - **Oil Filter**

16272 : **P115E** Labor - **Noise in engine**
 Removed oil pan and balance shafts to inspect crank. Found high amount of meta debris in the pan. Found the #3 rod bearing had spun and chewed up the crankshaft and rod

18213 : Labor - **LONG BLOCK - Remove & Replace** - LX - Consists of a **Cylinder Block** fitted with **Pistons, Rings, Connecting Rods, Crankshaft** and all **Bearings, Cylinder Head(s), Camshaft(s), Timing Chain or Belt** and **Sprockets or Gears**.<\n>Includes (where applicable): **Clean**

FAILURE: ENGINE OIL FILTER FAILED ☒ COMPONENT ☐ SYMPTOM_SUB_TYPE ☐ SYMPTOM_TYPE ☐ features

Make: **FORD** Model: **FIESTA** Year: **2017** Mileage: **31,135** Reported Date: **2021/04/05** Complaint Source: **VEHICLE OWNER'S QUESTIONNAIRE [WEBSITE]**

AFTER AN **OIL** CHANGE, **OIL** COMPLETELY DRAINED FROM **ENGINE**. NO VISIBLE LEAK FROM **OIL** PAN PLUG OR **OIL** FILTER. DT THE CONSUMER STATED THE FAILURE WAS DETERMINED TO BE AN UNTIGHTENED **OIL** FILTER.

Make: **JEEP** Model: **CHEROKEE** Year: **2017** Mileage: **22,300** Reported Date: **2021/03/04** Complaint Source: **VEHICLE OWNER'S QUESTIONNAIRE [WEBSITE]**

OIL FILTER HOUSING COOLER LEAKS AND POOLS **OIL** ON TOP OF **ENGINE**. PART NUMBER 68105583AF, **OIL** DRAINS DOWN EITHER SIDE OF THE **ENGINE**. IT IS A PLASTIC PART THAT CAN EASILY FAIL DUE TO DEALER OVER LIGHTNING THE **OIL** FILTER WHEN PERFORMING AN **OIL** CHANGE. LEAK STARTS IMMEDIATELY THIS **CAR** HAS 22,300 MILES ON IT AND IS A 2017.

Make: **HYUNDAI** Model: **SANTA FE** Year: **2017** Mileage: **80,000** Reported Date: **2020/11/25** Complaint Source: **VEHICLE OWNER'S QUESTIONNAIRE [HOTLINE]**

TL THE CONTACT OWNS OWN A 2017 HYUNDAI SANT FE. THE CONTACT STATED THAT WHILE DRIVING, THE **VEHICLE** LOSS MOTIVE **POWER** WITH THE CHECK **ENGINE** **WARNING LIGHT** ILLUMINATED. ADDITIONALLY, THERE WAS A RUBBING AND FRICTION SOUND COMING FROM UNDER THE **HOOD**. THE MANUFACTURER INFORMED THE CONTACT THAT THE **VEHICLE** WAS NOT INCLUDED IN NHTSA CAMPAIGN NUMBER 17V578000 **ENGINE** AND **ENGINE** COOLING. THE **VEHICLE** WAS TOWED TO SYCAMORE HYUNDAI 1380 DEKALB AVENUE, SYCAMORE, IL 60178, 815 895 4584 TO BE DIAGNOSED. THE CONTACT WAS INFORMED THAT THE **ENGINE** FAILED AND THERE WAS METAL SHAVINGS IN THE **OIL** FILTER. THE **VEHICLE** WAS NOT REPAIRED. THE APPROXIMATE FAILURE MILEAGE WAS 80,000. INVALID VIN.

SYMPTOM: NOISE HEARD FROM ENGINE ☐ COMPONENT ☒ SYMPTOM_SUB_TYPE ☒ SYMPTOM_TYPE ☐ features

Make: **KIA** Model: **K5** Year: **2021** Mileage: **3,285** Reported Date: **2021/03/26** Complaint Source: **VEHICLE OWNER'S QUESTIONNAIRE [WEBSITE]**

WHILE I WAS DRIVING ON THE INTERSTATE, I HEARD AND ABNORMAL ABOUT OF **NOISE** COMING FROM THE ENGINE BAY AS WELL AS A SCRATCH WHILE I WAS DRIVING. THIS HAPPENED ON MARCH 26, 2021 AT 10PM. ON MARCH 25, 2022 I TOOK IT TO THE DEALER SHIP AND I WAS NOTIFIED THAT MY ENGINE COVER **CAME OFF** AND WAS THE CAUSE OF THE **NOISE**. THERES **DAMAGE** TO MY DRIVER SIDE FENDER, RUBBING TO THE WHEEL TIRE AND MY FOG LIGHT HOUSING IS HANGING.

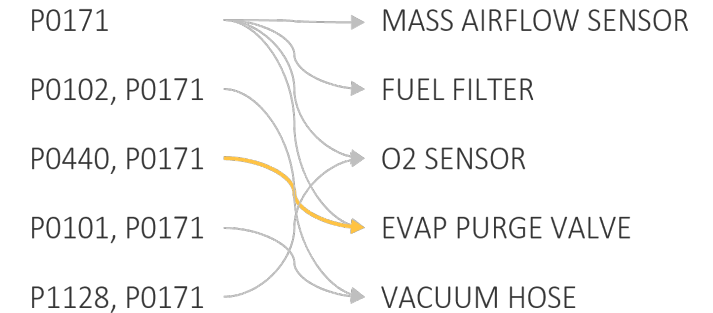
Make: **KIA** Model: **TELLURIDE** Year: **2021** Reported Date: **2021/02/12** Complaint Source: **VEHICLE OWNER'S QUESTIONNAIRE [WEBSITE]**

021 KIA TELLURIDE, FEBRUARY 13, 2021. TEMPERATURES ARE SINGLE DIGITS OR BELOW AND GOT WORSE AS THE WEEK WENT ON. **STARTED** THE ENGINE AND A **LOUD** **SQUEAL** OR **WHISTLING** **NOISE** CAME FROM THE TOP OF THE ENGINE. LAST ABOUT 30 SECONDS THEN SLOWLY **STOPS**. ENGINE ALSO STARTS TO **SOUND** LIKE IT HAS MORE POWER ONCE **NOISE** **STOPS**. BEEN GOING ON FOR THE LAST 8 DAYS. BELTS AND PULLEYS SEEM TO BE **WORKING**. FINE AND CANNOT SEE ANY **ISSUES**. **SOUND** LIKE IT IS COMING FROM UNDER THE ENGINE COVER BUT DO **NOT** WANT TO REMOVE COVER CAUSE TOO COLD AND DO **NOT** WANT TO JEOPARDIZE WARRANTY STIPULATIONS. CONTACTED MIDWEST KIA IN WICHITA, KANSAS. SENT THEM A VIDEO AND THEY THINK IT IS A VACUUM **LEAK**. OF SOME KIND. MIDWEST KIA SAID THEY CANNOT REPORT IT TO KIA UNTIL THEY CAN SEE THE CAR BUT WE ARE 2 HOURS AWAY AND CANNOT GET OFF **WORK**. TO TAKE IT AND NEED OUR CAR FOR **WORK**. I OWN A MORTUARY AND HAVE FUNERALS AND MY WIFE IS A TEACHER AND CANNOT GET SUBSTITUTES DO TO COVID. I SAID BASED ON MY RESEARCH IT **SOUNDS** LIKE INTAKE MANIFOLD. ON THE KIA FORUMS, MANY PEOPLE EXPERIENCING THESE VERY COLD TEMPS ARE EXPERIENCING THE SAME **NOISE** AND ENCOURAGED ME TO REPORT THE **ISSUE**. I FEEL IT IS COLD RELATED AND HOPE KIA LOOKS INTO THIS **PROBLEM**. THIS ONLY HAPPENS WHEN THE CAR HAS BEEN SITTING FOR SEVERAL HOURS. IF WE USE IT OFF AND ON WITHOUT SITTING TOO LONG THE **NOISE** **DOES NOT** HAPPEN. CAR **RUNS** GREAT ONCE THE **NOISE** **STOPS**.

FAILURE: THROTTLE BODY FAILED ☐ COMPONENT ☐ SYMPTOM_SUB_TYPE ☐ SYMPTOM_TYPE ☐ features

Make: **GMC** Model: **TERRAIN** Year: **2019** Reported Date: **2021/07/10** Complaint Source: **VEHICLE OWNER'S QUESTIONNAIRE [WEBSITE]**

Check engine light on, Reduced Power Light is on, and Vehicle is surging up and down. Driving on highway and Engine power is reduced, cars behind me honked until I could get over into the right lane because I was losing power. Yes, confirmed by LaFontaine of Ann Arbor, MI Yes. Inspected by LaFontaine of Ann Arbor MI Customer states check engine light on, reduced power light and the vehicle did have reduced power. Vehicle is surging up and down at an ideal. GM assistance, submit for DMA approval to deviate on PET per Scott S DMA. N C to customer per DMA, if an FSE is needed please submit request. Found air duct not connected to throttle body and throttle body is cause. Inspected and found air duct loose on throttle body. Inspected to find throttle body edge is worn and is cause. removed and replaced throttle body to address **Fast code P0101** 4021510 0.8 and add 1.0 diag yes, Engine Power is Reduced light and Engine light was on



Two examples of Future trends in Automotive Service



“John, Your 2019 BMW X3 needs service”



“What are my vehicle’s top Safety Concerns?”

“John, Your 2019 BMW X3 needs service.”

1. Vehicle IOT Trigger



DTC, PID via Telematics

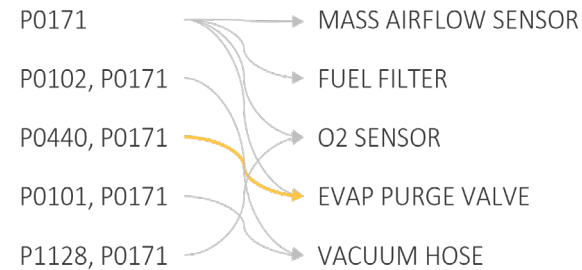
2. Upstream Analytics



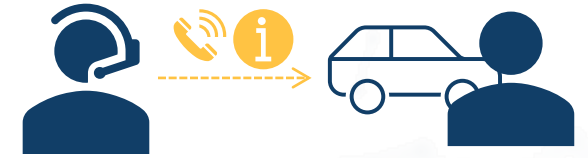
Min, Max, Anomalies *isolated*

3. Overlay & Correlate

Overlaying with insights from repair orders (textual)



5. Pro-active CRM



6. Parts Ordering



BMW Vapor Canister
Purge Solenoid -
Genuine BMW
13907618647
\$97.99
FCP Euro
Free shipping

7. Vehicle Repair



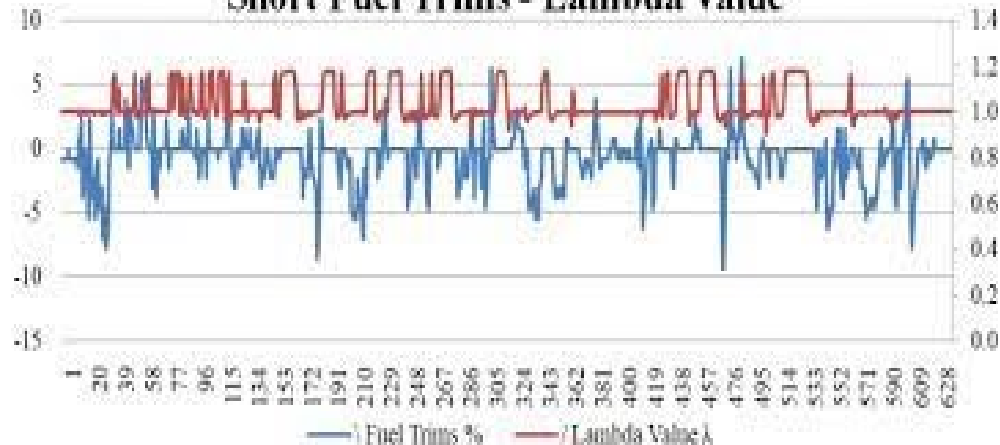
4. Predict Parts Replacement



Vehicle YMME & mileage specific

DTC(P0171,P0440),Short Fuel Trims(%),O2 Sensor(v)

Short Fuel Trims - Lambda Value



event=startup&ssnId=06f4c1505469fb0eff1b×tamp=10:55%20AM&system=Electrical=&frameNumber=141&Door%20Lock=true&Power=on&Temp=98.8&Roller=active&Rate=1.2&Pressure=67.....

“What are my vehicle’s top Safety Concerns?”



Important Conferences and Journals

- ACL
- EMNLP
- COLING
- NAACL
- EACL
- AACL-IJCNLP
- TACL
- CL
- AAAI, IJCAI, NeurIPS, CVPR, ICML, ICLR, ICCV, ECCV
- + many relevant workshops

Twitter: #NLProc

Thank you

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