How specialized AI drives value for Automotive Service Organizations

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Automotive Ecosystem Use Cases

- Fleets
- Insurers
- OEMs
- Dealers
- Aftermarket Service Providers
- Government Agencies
- Parts Suppliers
- Consumers

**Manufacture**
- Vehicle Sales Forecast
- Repair Diagnostics
- Predictive Maintenance

**Sell**
- Vehicle Design
- Residual Value
- Parts Production Forecast
- Repair Estimation

**Operate**
- Repair Cycle Time
- Emission Levels
- Shop Equipment Utilized

**Repair**
- Parts Replacement Occurrence
- Driver Behavior
- Collision Severity
- Parts Performance and Wear

**Remarket**
- New / Used Vehicle Sale Prices
- Labor Rates Incurred
- Parts Replacement Occurrence
- Diagnostic Trouble Codes

**Salvage**
- Production Costs
- Replacement Part SKUs
- Vehicle Design Specifications
- Emissions Levels

- Parts Pricing (Listed / Paid)
- Repair Cycle Time
- Parts Performance and Wear

Source: Jefferies
Automotive Data is unstructured, complex.

- Trillion total global market
- Billion vehicles in operation globally
- Million jobs in the US
- Years average age of light vehicles (US cars & light trucks)
- Make, model, engine, transmission combinations

- $2 Trillion total global market
- 2% of US nominal GDP
- 12.2 Years average age of light vehicles
- 4.7 Million jobs in the US
- 1.4 Billion vehicles in operation globally
- 100K Make, model, engine, transmission combinations
- 2% of US nominal GDP
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; multilingual 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

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
- Models need to be explainable
- Models should have high confidence
- Models need ‘deep contextual understanding’ in specialized domain

When will breakdowns happen and why?
Which repair will resolve the issue?
Which issues are a safety concern?
MLOps & Cloud native AI Pipeline drive actionable decisions

- Odometer 90,062 / 2019 / BMW X3

**RO Lines**

18221: Part - Oil Filter

18219: Part - Oil

18220: Part - Oil Filter

16272: P1118: Labor - Noise in engine
- Removed oil pan and balance shaft to inspect crank. Found high amount of meta debris in the pan. Found the #2 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 (<in>Includes (where applicable): Clean

**Failure: Engine Oil Filter Failed**

- Make: P20 Model: BEW Year: 2017 Mileage: 81,199 Reported Date: 2021/06/49 Complaint Source: VEHICLE OWNER'S QUESTIONNAIRE (WEBSITE)

- Make: JEEP Model: CHEROKEE Year: 2017 Mileage: 25,120 Reported Date: 2021/06/56 Complaint Source: VEHICLE OWNER'S QUESTIONNAIRE (WEBSITE)

- Make: HONDA Model: CIVIC TYPE Year: 2017 Mileage: 86,860 Reported Date: 2021/06/24 Complaint Source: VEHICLE OWNER'S QUESTIONNAIRE (WEBSITE)

**Symptom Noise Heard from Engine**

- Make: MAZ Model: 3S Year: 2011 Mileage: 2,639 Reported Date: 2016/12/31 Complaint Source: VEHICLE OWNER'S QUESTIONNAIRE (WEBSITE)

- Make: MAZ Model: TESLEZSU Year: 2013/07/20 Reported Date: 2017/07/24 Complaint Source: VEHICLE OWNER'S QUESTIONNAIRE (WEBSITE)

**Failure: Throttle Body Failed**

- Make: GAC Model: NEWG Year: 2018 Reported Date: 2021/07/15 Complaint Source: VEHICLE OWNER'S QUESTIONNAIRE (WEBSITE)

**Mass Airflow Sensor**

**Fuel Filter**

**O2 Sensor**

**Evap Purge Valve**

**Vacuum Hose**
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

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

3. Overlay & Correlate
   Overlaying with insights from repair orders (textual)

   - P0171
   - P0102, P0171
   - P0440, P0171
   - P0101, P0171
   - P1128, P0171

   MASS AIRFLOW SENSOR
   FUEL FILTER
   O2 SENSOR
   EVAP PURGE VALVE
   VACUUM HOSE

4. Predict Parts Replacement
   Vehicle YMME & mileage specific

5. Pro-active CRM

6. Parts Ordering
   BMW Vapor Canister Purge Solenoid - Genuine BMW 13997618647
   $27.99
   EGR Fung
   Free shipping

7. Vehicle Repair
“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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