



What every leader should know about generative AI

Future Networked Car Symposium 2024

Danny Smith

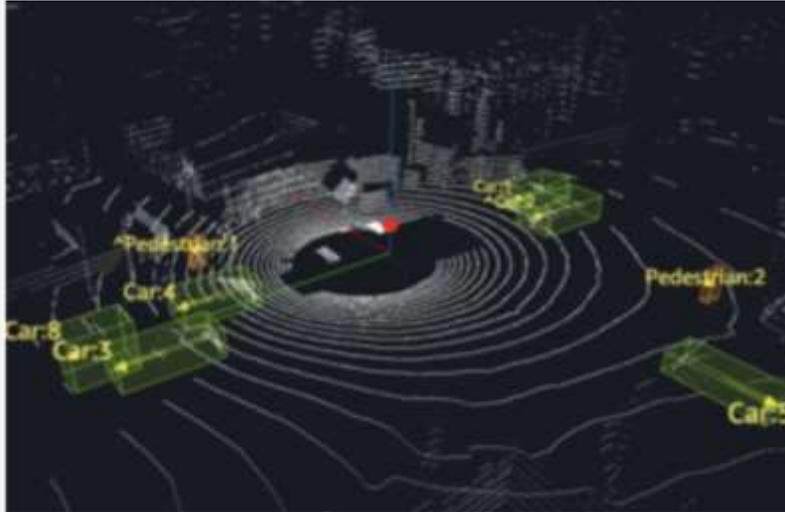
Principal Strategist | AI/ML | Automotive, Industrials, and Manufacturing

Amazon Web Services

Topics

- Current situation and the rise of generative AI
- Highlight of generative AI use-cases in Automotive
- Important considerations and learnings

Automotive has deep AI/ML expertise in niche areas...

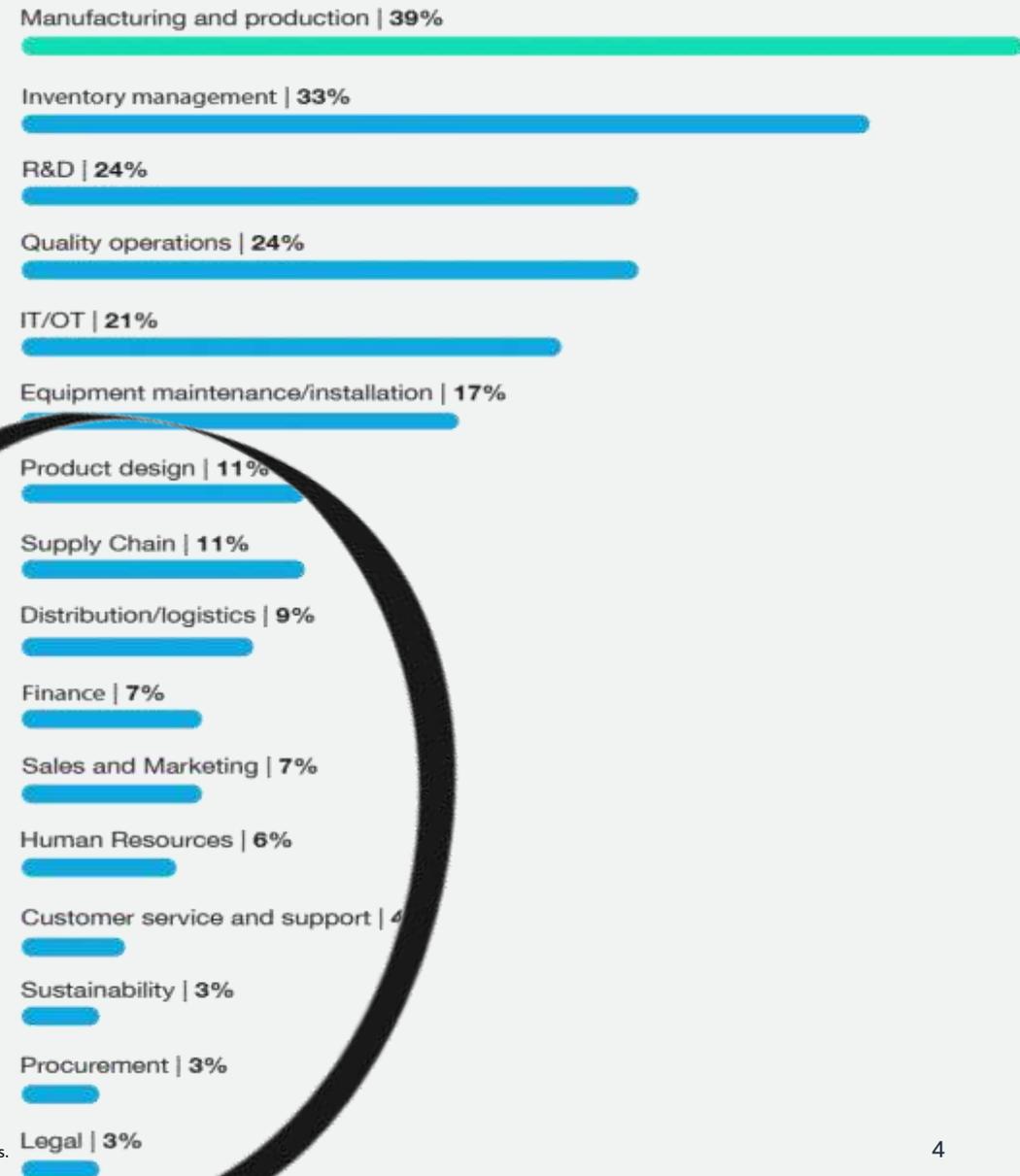


...but still early days for AI/ML: many areas largely untouched...



MANUFACTURING AND PRODUCTION TOP THE LIST OF CORPORATE AI IMPLEMENTATIONS

Which of the following corporate functions has begun the adoption of AI? (all that apply)



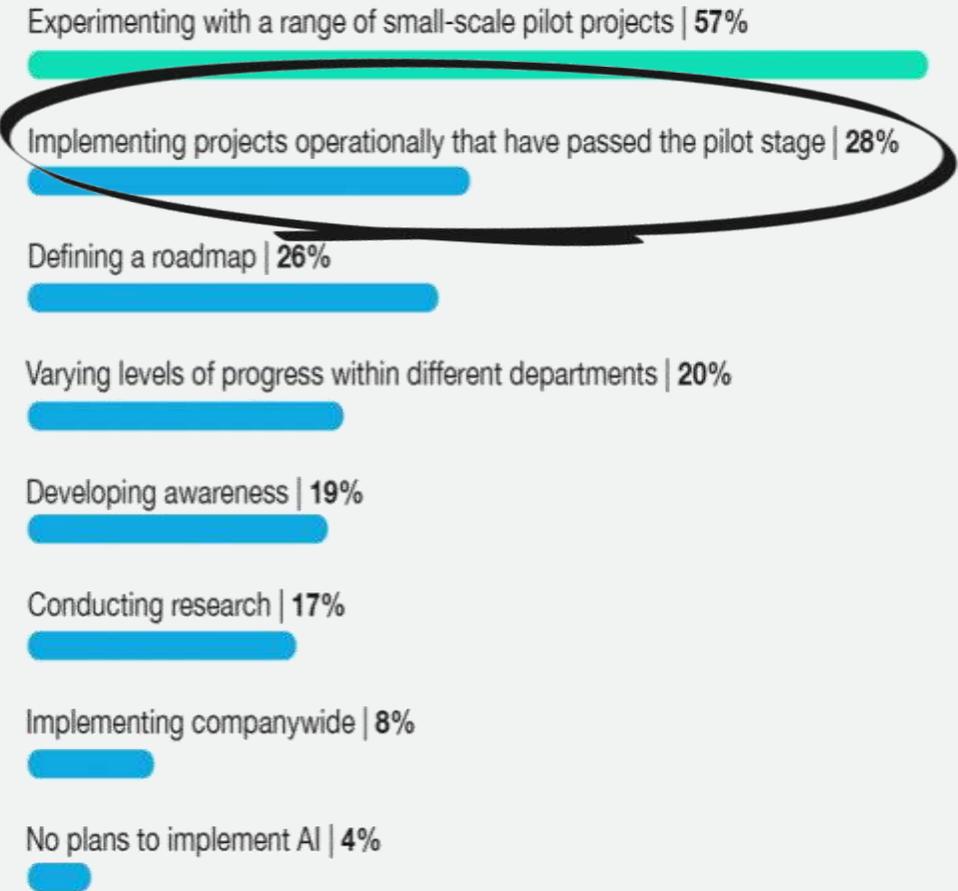
Source: Manufacturing Leadership Council

...and most experimenting only

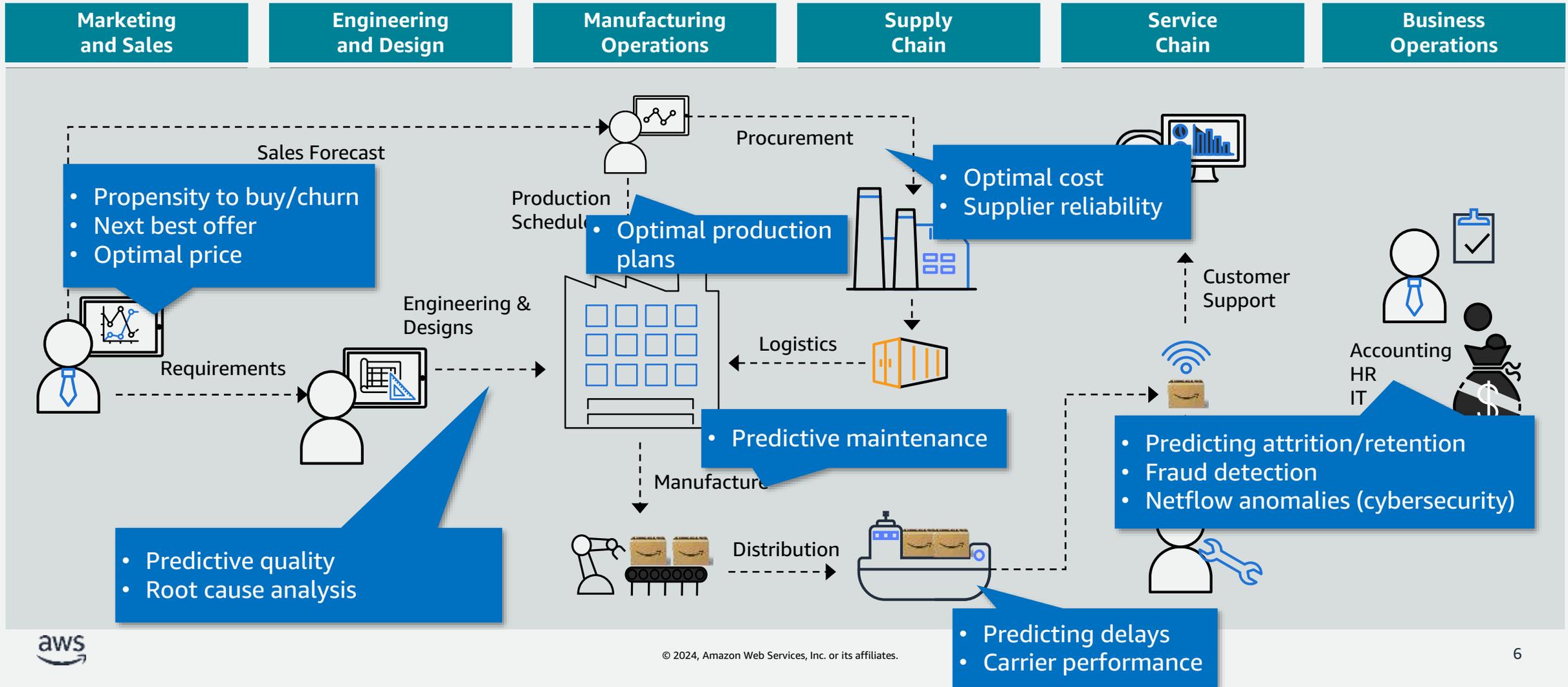


TWENTY EIGHT PERCENT ALREADY HAVE OPERATIONAL AI PROJECTS IN PLACE, BUT IT'S STILL EARLY DAYS IN AI ADOPTION FOR MOST

What is the overall progress level for AI across your company? (all that apply)



Are we fully leveraging traditional machine learning? No...



Data contextualization is the biggest challenge

DATA ISSUES DOMINATE THE CHALLENGES OF AI ADOPTION

What do you see as the biggest challenges to AI adoption in your organization today? (Top 3)

Data issues (access, format, integration, privacy, governance) | 65%

Lack of appropriate skills | 43%

Understanding the business case | 40%

Need to upgrade legacy equipment | 37%

Lack of C-Suite support | 32%

Understanding the technology | 31%

Fear of a lack of management control | 19%

Fear of bad decisions/embedded bias in algorithms | 12%

Workforce resistance | 4%

Ethical concerns | 4%

No current challenges | 3%

UNDERSTANDING DATA'S CONTEXT IS THE BIGGEST AI DATA CHALLENGE

What areas of working with AI-related data are proving most challenging? (Top 3)

Contextualization | 56%

Validation | 32%

Noisy data | 32%

Poor quality data | 30%

Computation | 28%

Not enough data | 25%

Connection | 25%

Ingestion and storage | 22%

Too much data | 19%

Security | 17%

Selecting | 11%



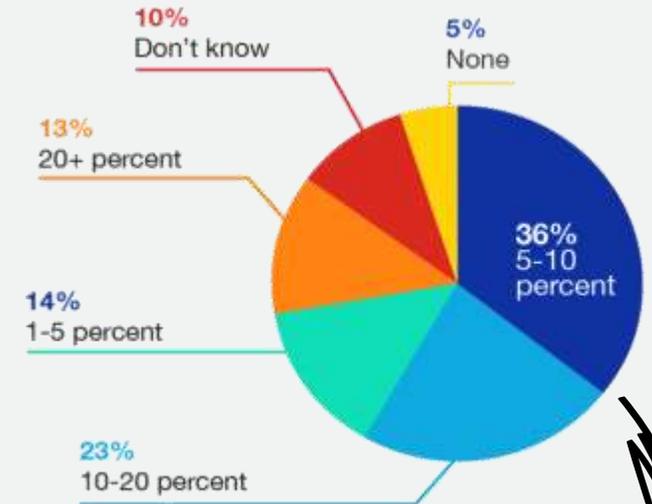
Workforce realignment expected, but not budgeted!?



Source: Manufacturing Leadership Council

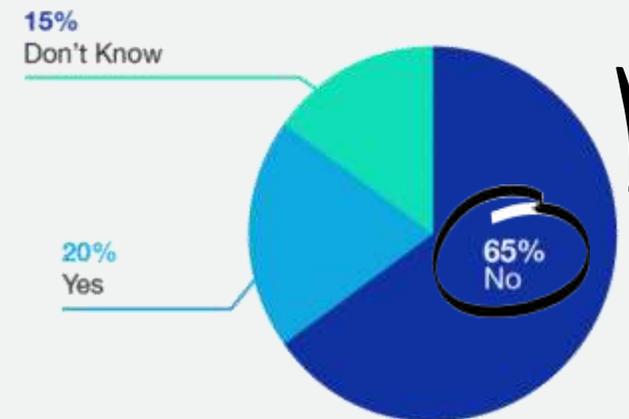
ONE-THIRD EXPECT TO RETRAIN OR REASSIGN OVER 10% OF THEIR WORKFORCE DUE TO AI

What percentage of the workforce displaced by AI adoption do you expect to be retrained or reassigned for other roles in your company by 2030?

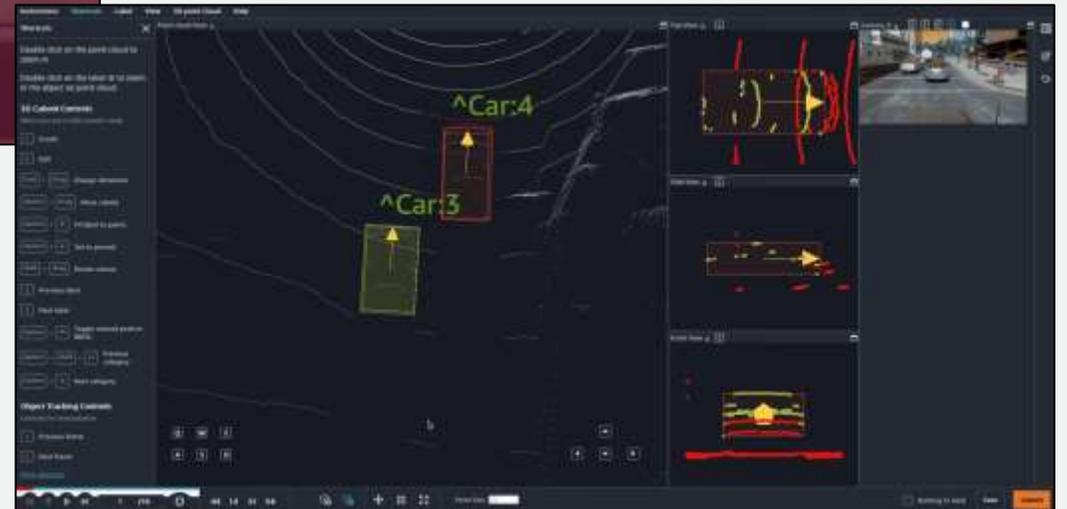
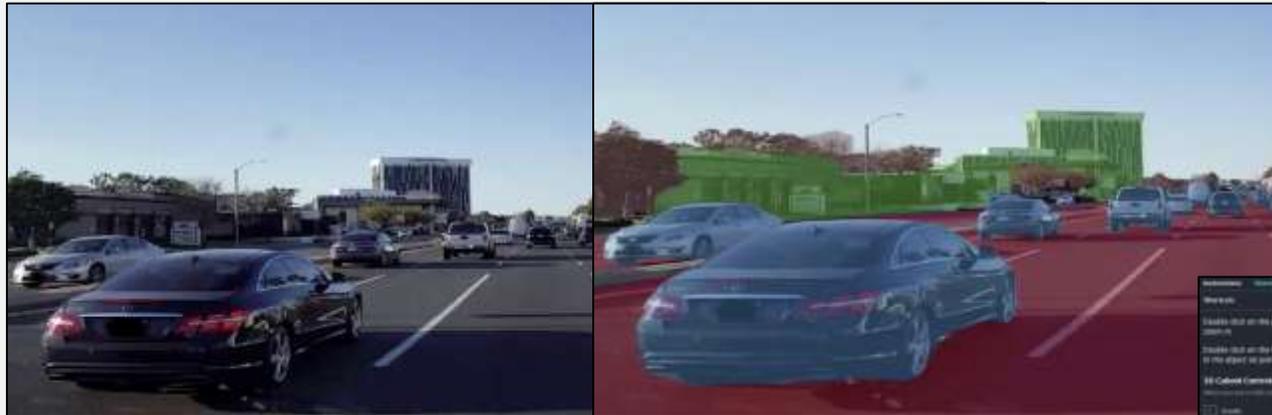


TWO-THIRDS STILL HAVE NO DEDICATED BUDGET FOR AI TRAINING

Does a dedicated budget exist within your company for AI technology training and education?



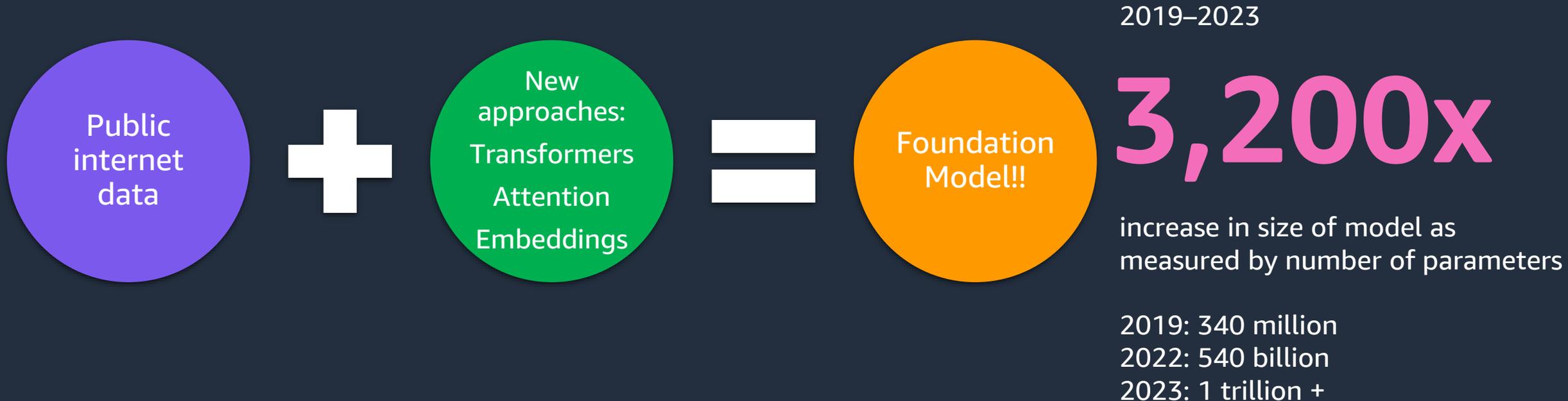
Traditional ML: we teach the ML model by labeling data (e.g this is a “car”) and then training a model on the data



Generative AI is different

The **students** **opened** their *books* 9.6
laptops 9.2
eyes 5.3
mouths 3.3
gifts 3.1
windows 2.7
doors 2.1

Generative AI has been trained on most of the internet



Common types of foundation models

Input



FM



Output

“Summarize the articles on impact of walking on heart health”

Text-to-text
Generate text from natural language prompts

“Ten thousand steps per day is optimum for maintaining a healthy heart”

“a photo of an astronaut riding a horse on mars”

Text-to-image
Create and edit images using natural language prompts



Generative AI is different: why did my car break down?



Generative AI is different: why did my car break down?

What do P0011, P0012, and P0016 error codes have in common?

The P0011, P0012 and P0016 error codes are all related to the variable camshaft timing (VCT) system.

Specifically:

P0011 - Intake Camshaft Position Timing - Over-Advanced (Bank 1) P0012 - Timing - Over-Retarded (Bank 1) P0016 - Crankshaft Position - Camshaft Position Sensor A

These codes indicate there is an issue with the VCT system on Bank 1 (the left side of the engine). The common causes for these codes are:

- Faulty camshaft timing/position sensor
- Faulty camshaft actuator solenoid
- Stretched or broken timing chain
- Worn or broken timing chain

The VCT system uses oil pressure and solenoids to advance or retard the camshaft. If there is an issue with the sensors, solenoids or actuators in this system, it can set these error codes and timing over-advanced/retarded codes. Diagnosing VCT related codes involves testing camshaft sensors, actuators and solenoids, and verifying proper camshaft timing.

So in summary, the commonality between P0011, P0012 and P0016 is that they all indicate an issue with the variable camshaft timing system on Bank 1 of the engine. Diagnosing these codes would involve testing the same VCT components.

what error codes would I see with camshaft problems?

Some common camshaft related diagnostic trouble codes (DTCs) include:

- P0011 - Intake Camshaft Position Timing - Over-Advanced (Bank 1)
- P0012 - Intake Camshaft Position Timing - Over-Retarded (Bank 1)
- P0013 - Exhaust Camshaft Position Actuator Circuit/Open (Bank 1)
- P0014 - Exhaust Camshaft Position Timing - Over-Advanced (Bank 1)
- P0015 - Exhaust Camshaft Position Timing - Over-Retarded (Bank 1)
- P0016 - Crankshaft Position - Camshaft Position Correlation (Bank 1)
- P0017 - Crankshaft Position - Camshaft Position Correlation (Bank 2)
- P0018 - Crankshaft Position - Camshaft Position Correlation (Bank 1)
- P0019 - Crankshaft Position - Camshaft Position Correlation (Bank 2)
- P0020 - Intake Camshaft Position Actuator Circuit/Open (Bank 1)
- P0021 - Intake Camshaft Position Timing - Over-Advanced (Bank 1)
- P0022 - Intake Camshaft Position Timing - Over-Retarded (Bank 1)
- P0023 - Exhaust Camshaft Position Actuator Circuit Ran

These codes indicate there could be issues with the camshaft timing system, camshaft actuator, timing chain or other camshaft timing related components. The specific code will indicate to which part of the system needs to be diagnosed.

Some possible causes for these camshaft related codes include:

- Faulty camshaft position sensor
- Camshaft actuator solenoid malfunction
- Stretched or broken timing chain
- Worn or damaged camshaft/crankshaft sprockets
- Faulty camshaft actuator

what could cause cam shaft problems?

Some possible causes for camshaft related problems could be:

- Worn or damaged camshaft lobes: The camshaft lobes activate the valves by pushing on the valve lifters. Worn or damaged camshaft lobes won't be able to properly activate the valves, causing issues like rough idle, misfires, loss of power, etc.
- Camshaft timing issues: If the camshaft timing is off, the valves won't be activated at the proper time relative to the position of the pistons. This can also cause problems like rough idle, misfires, loss of power, etc. Camshaft timing issues can be caused by a worn camshaft timing chain, faulty camshaft timing actuators or phasers, etc.
- Camshaft position sensor issues: The camshaft position sensor monitors the position and speed of the camshaft. Faulty camshaft position sensors can cause issues like no-start, stalling, rough idle, misfires, loss of power, etc.
- Camshaft advance/retard system issues: Some engines use computer controlled camshaft advance/retard systems to optimize engine performance and emissions. Faults in these systems can also lead to drivability and performance issues.
- Blocked or stuck hydraulic lifters: Hydraulic lifters are used to activate the valves by transferring motion from the camshaft lobes to the valves. Blocked or stuck hydraulic lifters won't be able to properly activate the valves, leading to problems like misfires, loss of power, rough idle, etc.
- Bent or damaged camshaft: A bent or damaged camshaft won't be able to properly activate all the engine valves, resulting in severe drivability and performance issues. This type of damage usually requires replacement of the camshaft.
- Faulty camshaft actuators or phasers: Some engines use computer controlled camshaft actuators or camshaft phasers to adjust camshaft timing for optimal performance and emissions. Faulty actuators or phasers can cause camshaft timing issues and the associated drivability problems.

So in summary, camshaft related problems can often cause issues like rough idle, misfires, loss of power, stalling, and no-start conditions. The specific causes can include camshaft wear or damage, camshaft timing faults, camshaft position sensor issues, lifter problems, bent camshafts, and faulty camshaft advance/retard systems.

The rise of generative AI



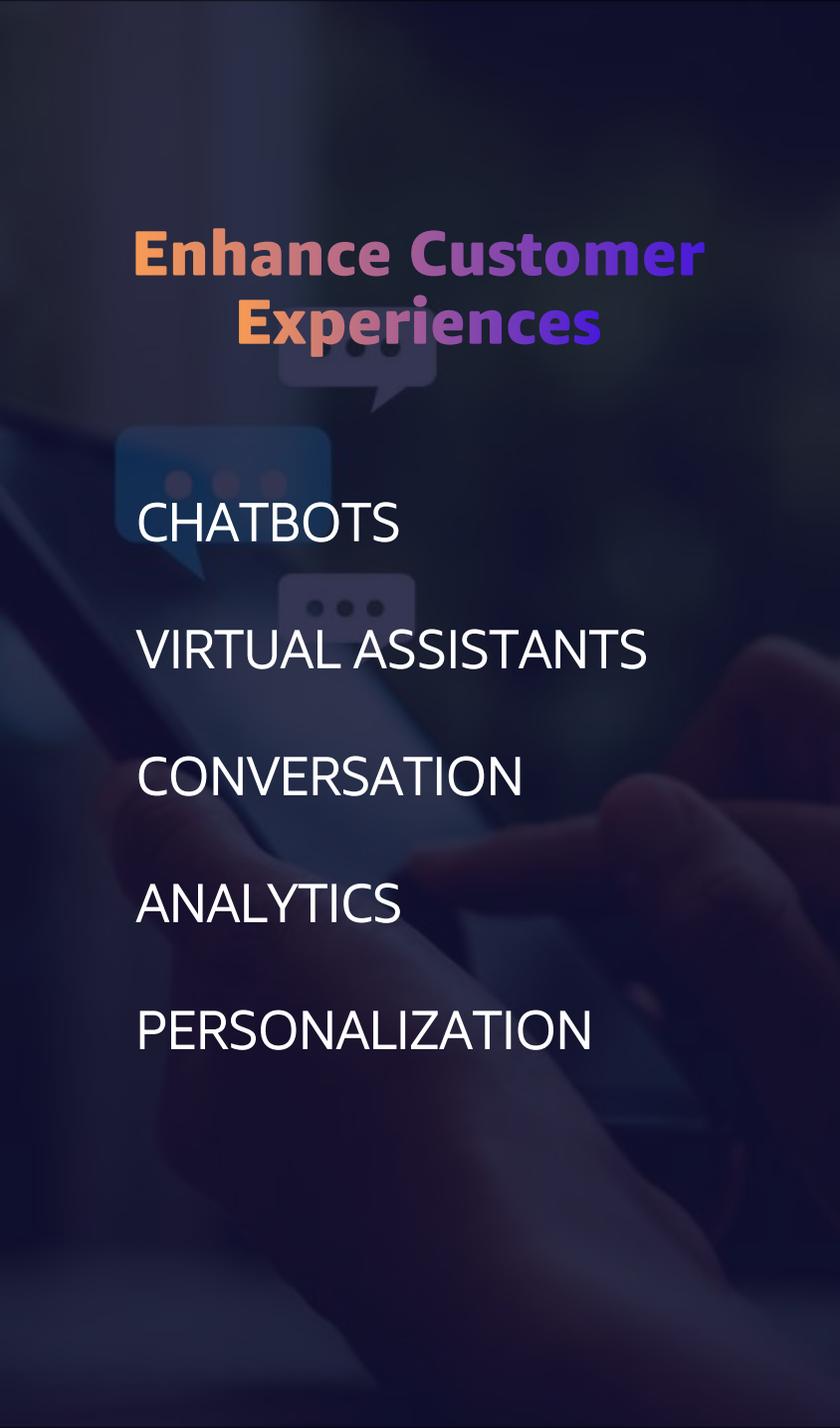


Accelerating people

**Enhance Customer
Experiences**

**Boost employee
productivity & creativity**

**Optimize business
processes**



Enhance Customer Experiences

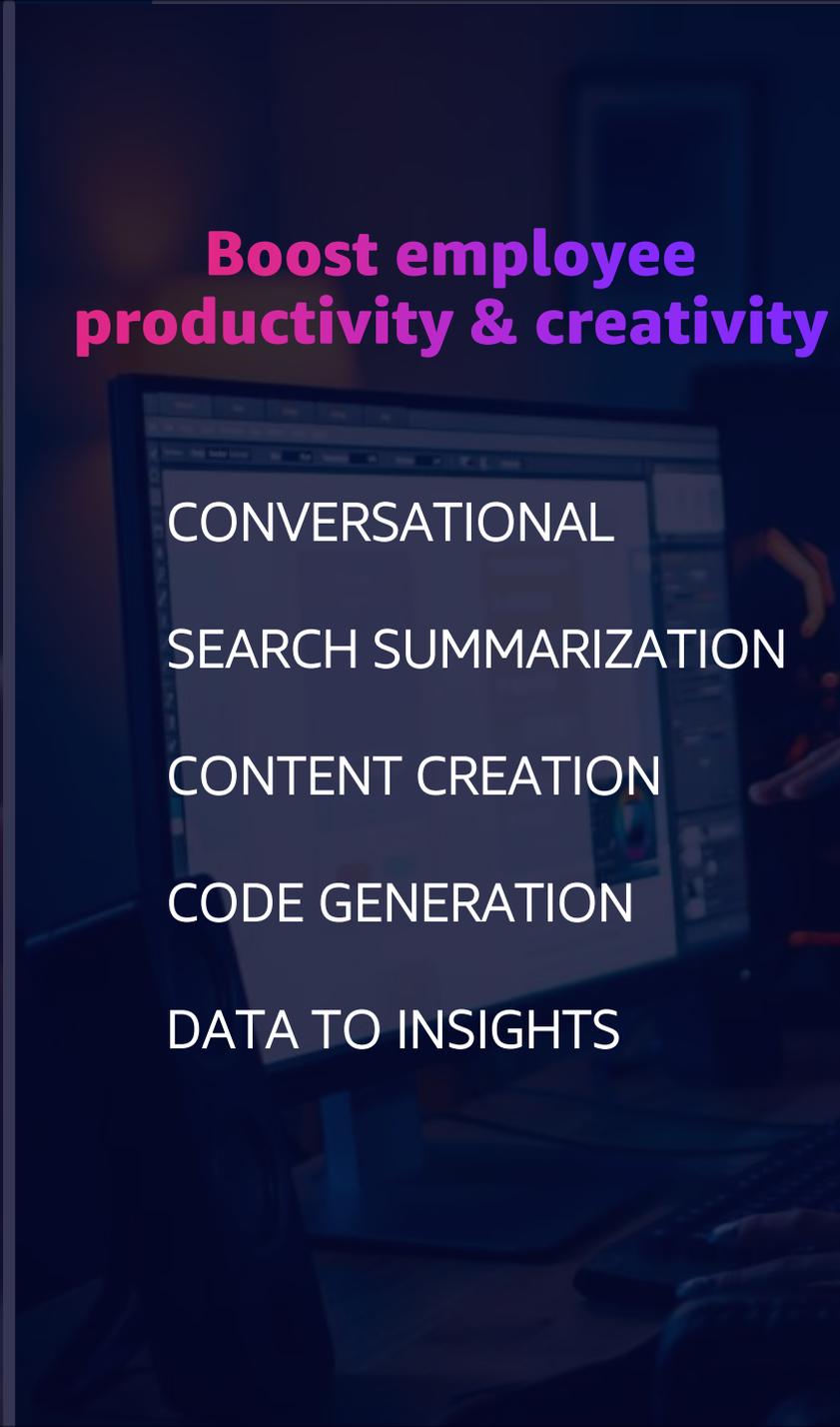
CHATBOTS

VIRTUAL ASSISTANTS

CONVERSATION

ANALYTICS

PERSONALIZATION



Boost employee productivity & creativity

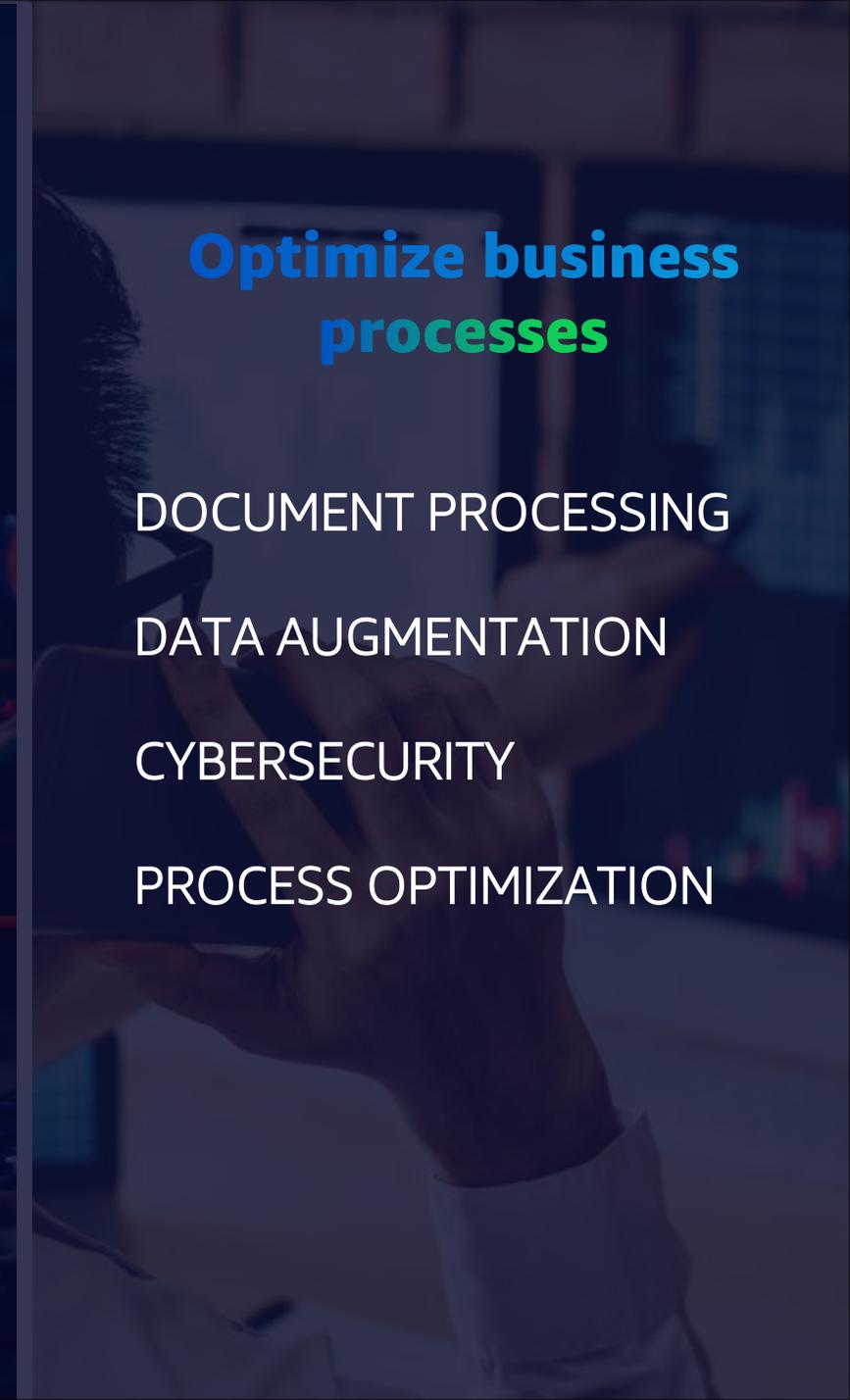
CONVERSATIONAL

SEARCH SUMMARIZATION

CONTENT CREATION

CODE GENERATION

DATA TO INSIGHTS



Optimize business processes

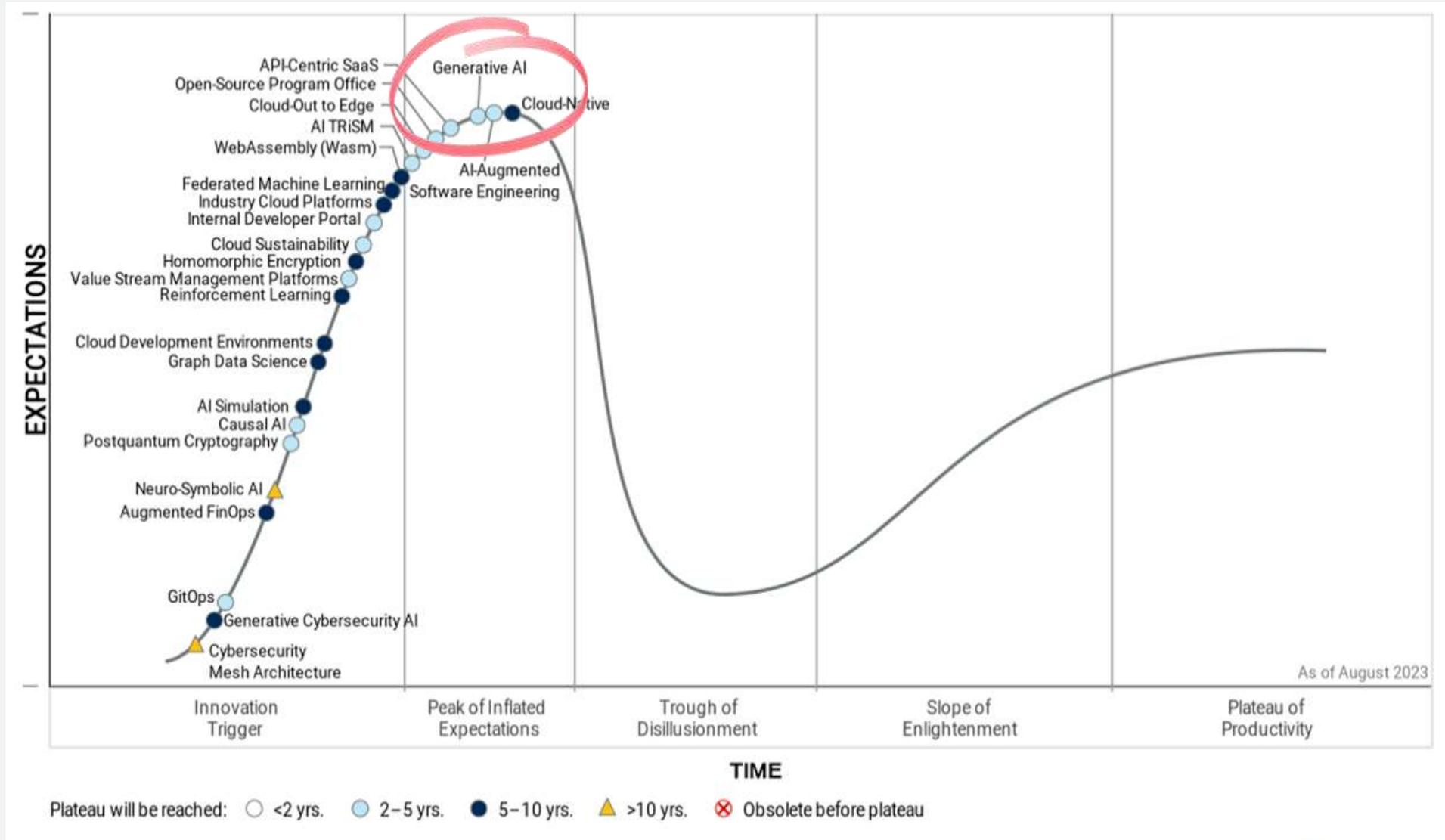
DOCUMENT PROCESSING

DATA AUGMENTATION

CYBERSECURITY

PROCESS OPTIMIZATION

Peak of inflated expectations?



Gartner Hype Cycle for Emerging Technologies, 2023

Why is generative AI is top-of-mind with executives?

McKinsey
Digital

QuantumBlack, AI by McKinsey

What every CEO should know about generative AI

Generative AI is evolving at record speed while CEOs are still learning the technology's business value and risks. Here, we offer some of the generative AI essentials.

This article is a collaborative effort by Michael Chiu, Roger Roberts, Tanya Rodchenko, Anik Singh, Alex Sukharovskiy, Larissa You, and Delphine Zukiy, representing views from the McKinsey Technology Council and QuantumBlack, AI by McKinsey, which are both part of McKinsey Digital.

<https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/what-every-ceo-should-know-about-generative-ai#/>

May 2023



McKinsey
& Company

The economic potential of generative AI

The next productivity frontier

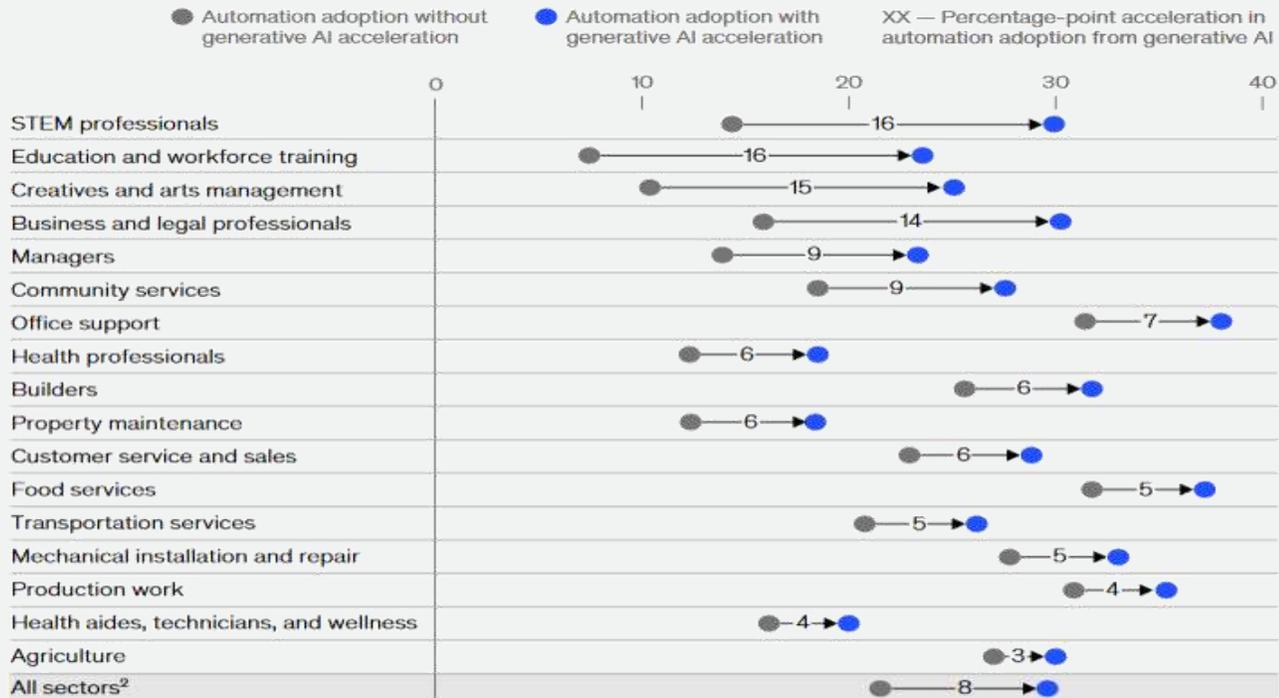
June 2023

<https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-economic-potential-of-generative-ai-the-next-productivity-frontier#/>

“...generative AI could add the equivalent of \$2.6 trillion to \$4.4 trillion of value annually”

The potential for accelerating work: 30% of hours automated by 2030

Midpoint automation adoption¹ by 2030 as a share of time spent on work activities, US, %



¹Midpoint automation adoption is the average of early and late automation adoption scenarios as referenced in *The economic potential of generative AI: The next productivity frontier*, McKinsey & Company, June 2023.
²Totals are weighted by 2022 employment in each occupation.
 Source: O*NET; US Bureau of Labor Statistics; McKinsey Global Institute analysis

GenAI will enable companies to automate manual tasks in the day to day business

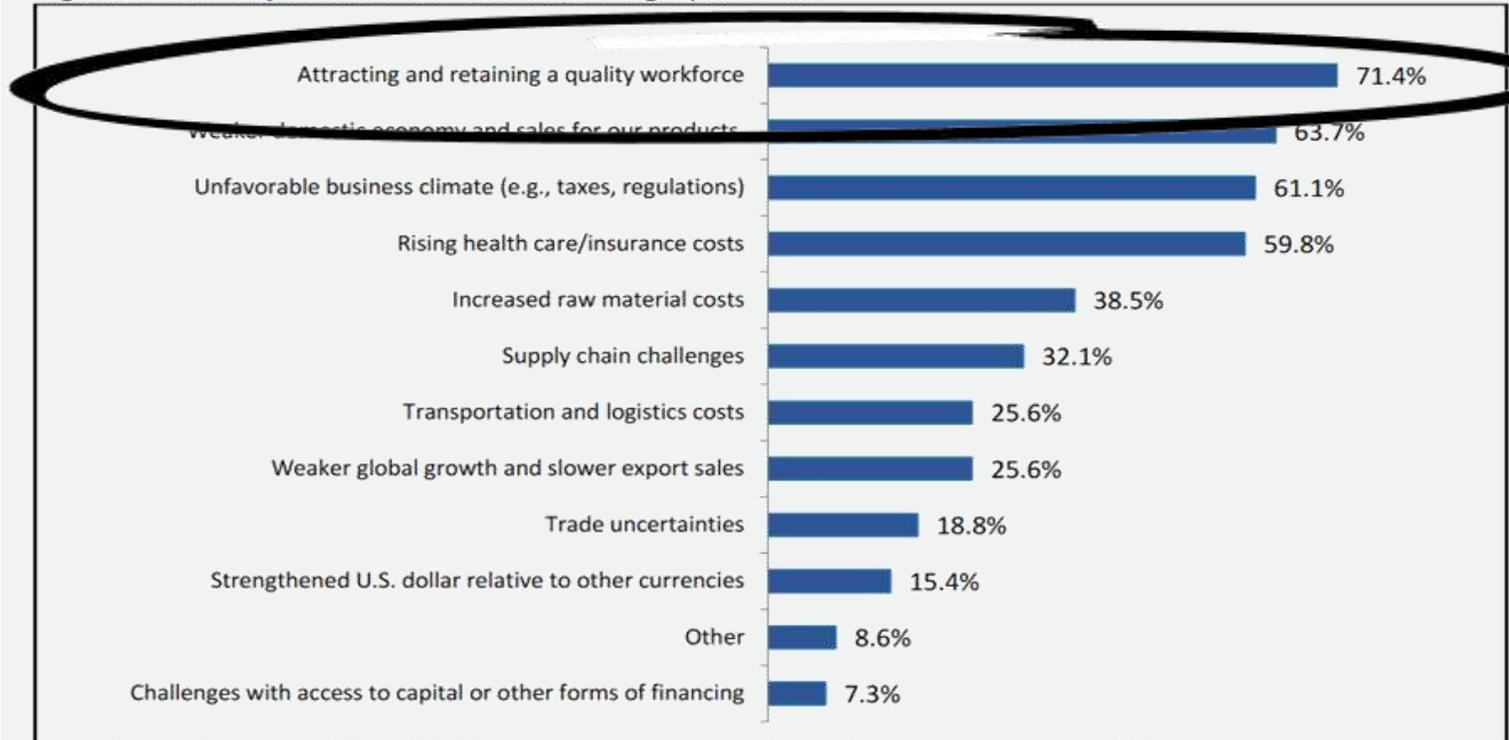


Securing talent continues to be the top concern



Source: Manufacturing Quarterly Outlook Survey

Figure 5: Primary Current Business Challenges, Q4 2023



Note: Respondents were able to check more than one response; therefore, responses exceed 100%.

Generative AI use-cases at one Automotive OEM

ACTIVE PROJECTS



Text generation, summarization, and smart search for contracts



Software development assistance



Technical specification assistants for buyer teams



Accelerating product design specification



Supply chain issue resolution assistance



Synthetic data generation



Interactive assistant for resolving quality issues



Training content generation



Faster knowledge transfer for new hires (SOP assistants)



Process improvements and acceleration

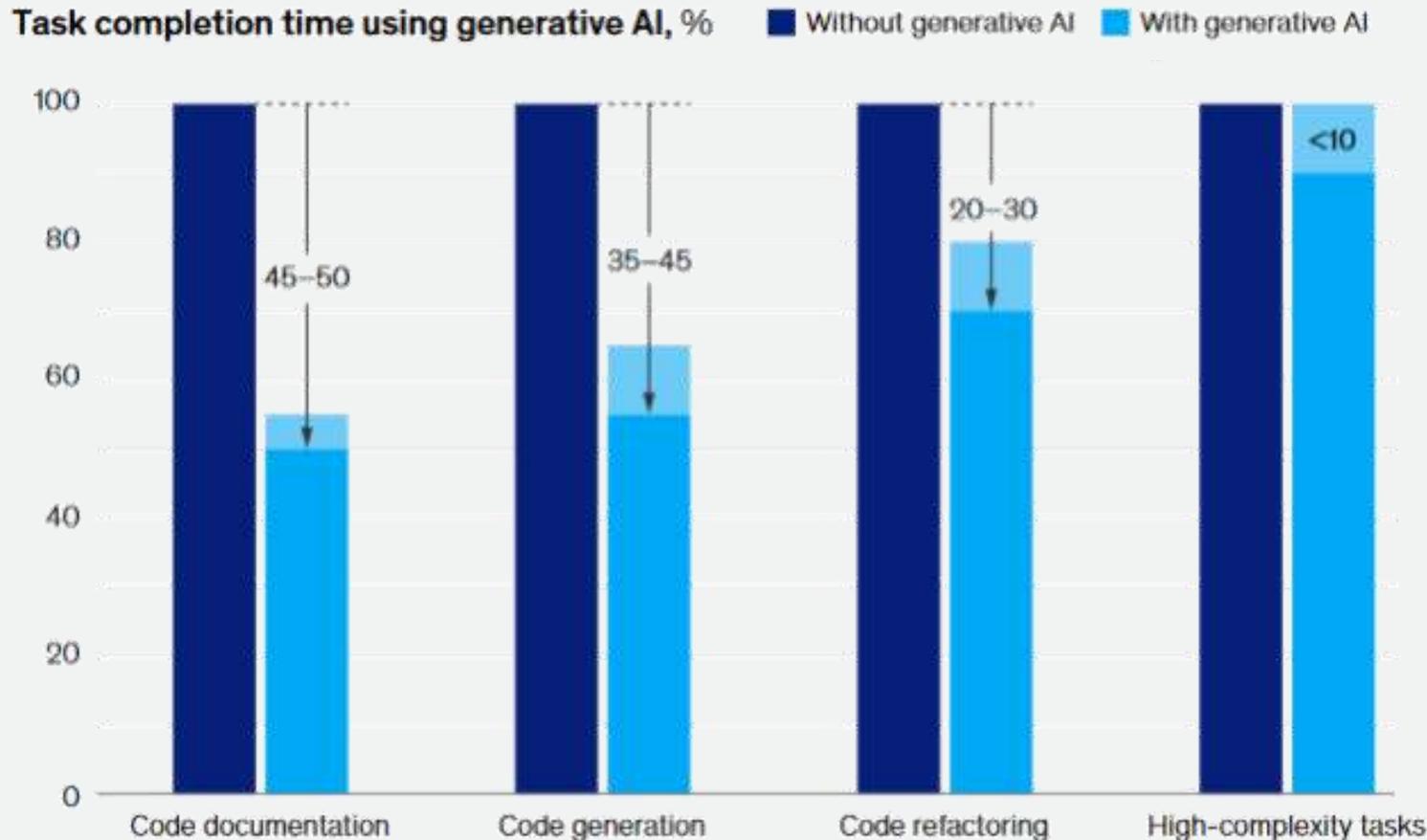
Popular Gen AI use-cases in Auto & Manufacturing

	Software Defined X	Autonomous Mobility	Smart Operations	Digital Customer Experience	Product Engineering
Text to Text	<ul style="list-style-type: none"> Coding assist Create test plans Interactive knowledge 	<ul style="list-style-type: none"> Coding assist 	<ul style="list-style-type: none"> Coding assist Interactive knowledge Natural language dashboards 	<ul style="list-style-type: none"> Coding assist Interactive knowledge Interactive chatbots Content creation 	<ul style="list-style-type: none"> Coding assist Interactive knowledge Accelerating MBSE
Text to Image	<ul style="list-style-type: none"> Generating diagrams/flow 	<ul style="list-style-type: none"> Synthetic training data edge cases – e.g. occlusion 	<ul style="list-style-type: none"> Synthetic training data (edge cases) 	<ul style="list-style-type: none"> Content creation Generative styling 	<ul style="list-style-type: none"> Accelerating MBSE
Other multi-modal systems	<ul style="list-style-type: none"> Optimized function calls 	<ul style="list-style-type: none"> Synthetic training data – missing/degraded sensor Data set creation – drone paths 	<ul style="list-style-type: none"> Interactive knowledge Process improvements 	<ul style="list-style-type: none"> Generative styling 	<ul style="list-style-type: none"> Generative design Accelerating MBSE

Top generative AI use-case: coding assistance



Value of coding assistance: 10-50% acceleration



**GenAI Tools
increase
developer
speed for
all coding
relevant tasks**



Value of coding assistance: BT Digital example

- 100,000 lines of code/ 4 months
- Helped automate **12%** of tedious, repetitive, time-consuming tasks
- Provided **15-20** suggestions/day/user
- Average acceptance rate of **37%**
- Now rolled out to **1200+** coders



Generative AI use-case #2: interactive documents



What do P0011, P0012, and P0016 error codes have in common?

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P0011 - Intake Camshaft Position Timing - Over-Retarded (Bank 1) P0016 Sensor A

These codes indicate there is an issue with the timing of the engine. The common causes for

- Faulty camshaft timing/position sensor
- Faulty camshaft actuator solenoid
- Jammed or broken camshaft actuator
- Worn or broken timing chain

The VCT system uses oil pressure and sensors to adjust camshaft timing. An issue with the sensors, solenoids or actuators can cause timing over-advanced/retarded conditions.

So in summary, the commonality between these error codes is an issue with the variable camshaft timing (VCT) system.

what error codes would I see with camshaft problems?

Some common camshaft related diagnostic trouble codes include:

- P0011 - Intake Camshaft Position Timing - Over-Advanced
- P0012 - Intake Camshaft Position Timing - Over-Retarded
- P0013 - Exhaust Camshaft Position Actuator Circuit/Open
- P0014 - Exhaust Camshaft Position Timing - Over-Advanced
- P0015 - Exhaust Camshaft Position Timing - Over-Retarded
- P0016 - Crankshaft Position - Camshaft Position Correlation
- P0017 - Crankshaft Position - Camshaft Position Correlation
- P0018 - Crankshaft Position - Camshaft Position Correlation
- P0019 - Crankshaft Position - Camshaft Position Correlation
- P0020 - Intake Camshaft Position Actuator Circuit/Open
- P0021 - Intake Camshaft Position Timing - Over-Advanced
- P0022 - Intake Camshaft Position Timing - Over-Retarded
- P0023 - Exhaust Camshaft Position Actuator Circuit/Open

These codes indicate there could be issues with the camshaft actuator, timing chain or other camshaft timing components.

Some possible causes for these camshaft related codes include:

- Faulty camshaft position sensor
- Camshaft actuator solenoid malfunction
- Stretched or broken timing chain
- Worn or damaged camshaft/crankshaft sprockets
- Faulty camshaft actuator
- Low oil level or incorrect oil viscosity

what could cause cam shaft problems?

Some possible causes for camshaft related problems could be:

- Worn or damaged camshaft lobes: The camshaft lobes activate the valves by pushing on the valve lifters. Worn or damaged camshaft lobes won't be able to properly activate the valves, causing issues like rough idle, misfires, loss of power, etc.
- Camshaft timing issues: If the camshaft timing is off, the valves won't be activated at the proper time relative to the position of the pistons. This can also cause problems like rough idle, misfires, loss of power, etc. Camshaft timing issues can be caused by a worn camshaft timing chain, faulty camshaft timing actuators or phasers, etc.
- Camshaft position sensor issues: The camshaft position sensor monitors the position and speed of the camshaft. Faulty camshaft position sensors can cause issues like no-start, stalling, rough idle, misfires, loss of power, etc.
- Camshaft advance/retard system issues: Some engines use computer controlled camshaft advance/retard systems to optimize engine performance and emissions. Faults in these systems can also lead to drivability and performance issues.
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So in summary, camshaft related problems can often cause issues like rough idle, misfires, loss of power, stalling, and no-start conditions. The specific causes can include camshaft wear or damage, camshaft timing faults, camshaft position sensor issues, lifter problems, bent camshafts, and faulty camshaft actuators or phasers.

Generative AI use-case #2: interactive documents (Q&A on knowledge stores a.k.a “RAG”)

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The P0011, P0012 and P0016 error codes are all related to the variable camshaft timing (VCT) system. Specifically:

P0011 - Intake Camshaft Position Timing - Over-Advanced (Bank 1) P0012 - Intake Camshaft Position Timing - Over-Retarded (Bank 1) P0016 - Crankshaft Position - Camshaft Position Correlation - Bank 1 Sensor A

These codes indicate there is an issue with the VCT system on Bank 1 (the bank that contains cylinder #1) of the engine. The common causes for these codes are:

- Faulty camshaft timing/position sensor
- Faulty camshaft actuator solenoid
- Jammed or broken camshaft actuator
- Worn or broken timing chain

The VCT system uses oil pressure and solenoids to advance or retard the camshaft timing. If there is an issue with the sensors, solenoids or actuators in this system, it can set these camshaft position correlation and timing over-advanced/retarded codes. Diagnosing VCT related codes typically involves testing the camshaft sensors, actuators and solenoids, and verifying proper camshaft timing.

So in summary, the commonality between P0011, P0012 and P0016 is that they all point to a potential issue with the variable camshaft timing system on Bank 1 of the engine. Diagnosing any of these codes would involve testing the same VCT components.

2007 PCED On Board Diagnostics SECTION 4: Powertrain DTC Charts and Descriptions
Procedure revision date: 03/28/2008

Diagnostic Trouble Code (DTC) Charts and Descriptions

Note: Refer to the applicable Workshop Manual section to diagnose the body and chassis DTCs.

P0010 - Intake Camshaft Position Actuator Circuit Open (Bank 1)

Description:	The powertrain control module (PCM) monitors the variable camshaft timing (VCT) circuit to the PCM for high and low voltage. The test fails if the voltage exceeds or falls below a calibrated limit for a calibrated amount of time.		
Possible Causes:	<ul style="list-style-type: none">• Open or short in the VCT circuit• Open VPWR circuit• Open or short in the VCT solenoid valve		
Diagnostic Aids:	This DTC is a circuit check. Testing should include the harness and solenoid coil.		
Application	Key On Engine Off	Key On Engine Running	Continuous Memory
All		GO to Pinpoint Test HK .	

P0011 - Intake Camshaft Position Timing - Over-Advanced (Bank 1)

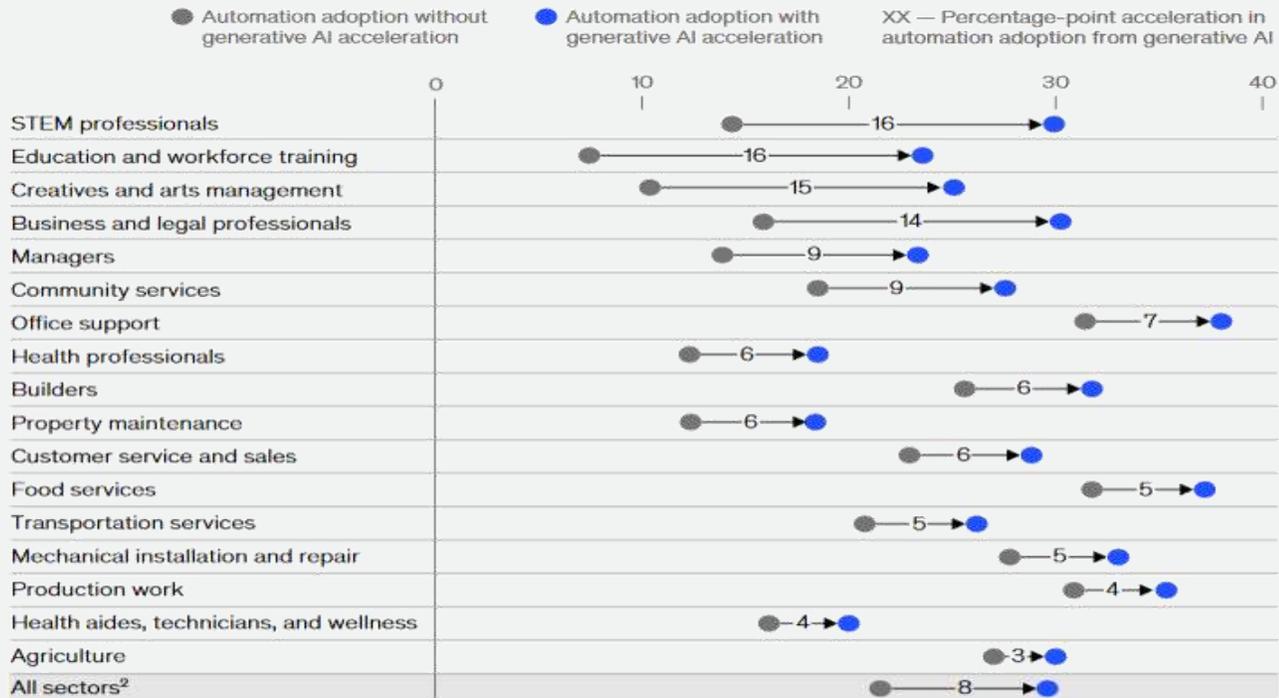
Description:	The powertrain control module (PCM) monitors the variable camshaft timing (VCT) position for an over-advanced camshaft timing. The test fails when the camshaft timing exceeds a maximum calibrated value or remains in an advanced position.		
Possible Causes:	<ul style="list-style-type: none">• Camshaft timing improperly set• Continuous oil flow to the VCT piston chamber• VCT solenoid valve stuck open• Camshaft advance mechanism binding (VCT unit)		
Diagnostic Aids:	This DTC is a functional check of the VCT unit. Diagnose any base engine concerns related to the engine oil pressure or engine timing. Refer to the Workshop Manual Section 303-00, Engine System.		
Application	Key On Engine Off	Key On Engine Running	Continuous Memory
All	—	GO to Pinpoint Test HK .	GO to Pinpoint Test HK .

Top generative AI use-case: natural language dashboards



How do we realize the acceleration of ALL work?

Midpoint automation adoption¹ by 2030 as a share of time spent on work activities, US, %

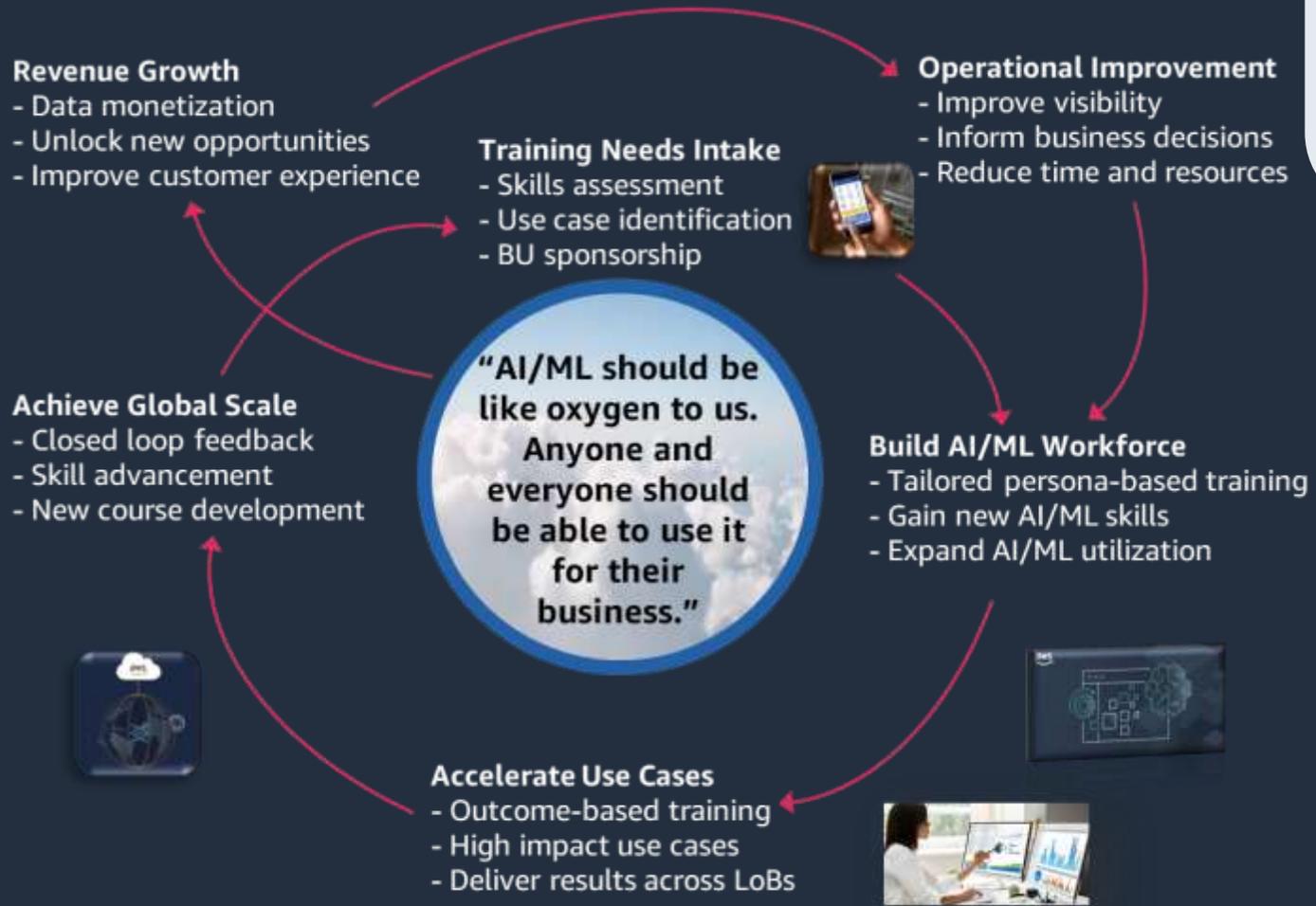


GenAI will enable companies to automate manual tasks in the day to day business

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²Totals are weighted by 2022 employment in each occupation.
 Source: O*NET; US Bureau of Labor Statistics; McKinsey Global Institute analysis

Flywheel for democratizing AI/ML

UPSKILLING THE ENTIRE ORGANIZATION



How do you accelerate the entire organization?

Give everyone access to generative AI is a good start

Sifting through petabytes of recorded driving logs to identify the critical and impactful 1% of data is a very challenging task in AM development

But useful data looks like this:

Much of driving data looks like this:



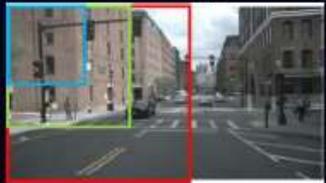
Solution overview

01 Feature extraction

Global embeddings



Hierarchical sliding window



Object-centric embeddings



02 Querying

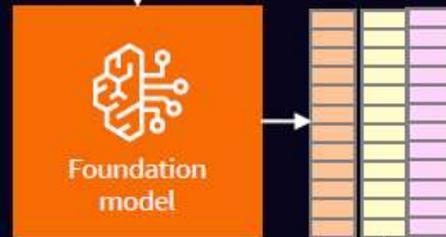
Query images



Query text



Query feature embeddings



Match and rank Results

03 Search results



How Torc Robotics uses foundation models for data discovery

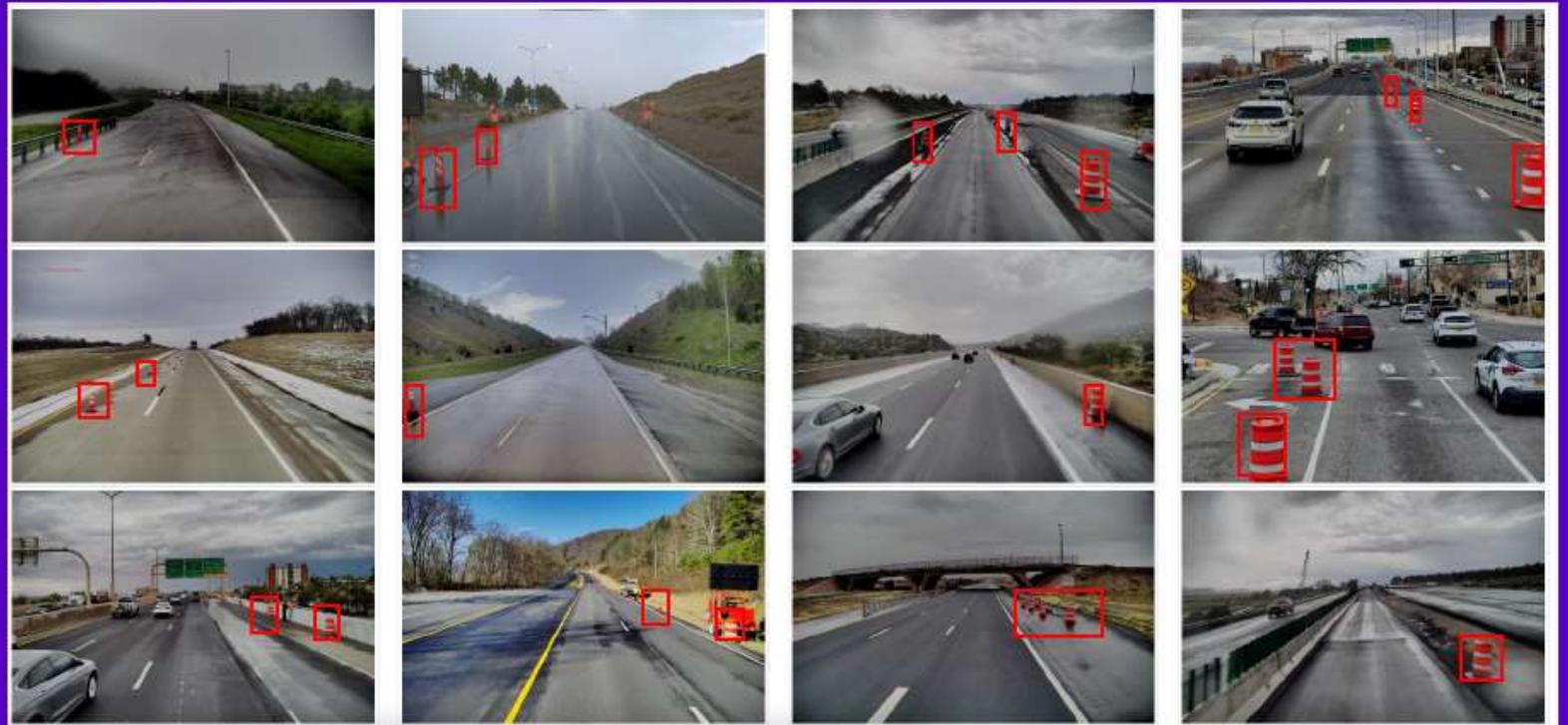
Query:



*"a rainy day"
"wet road"*

Sample retrieval results

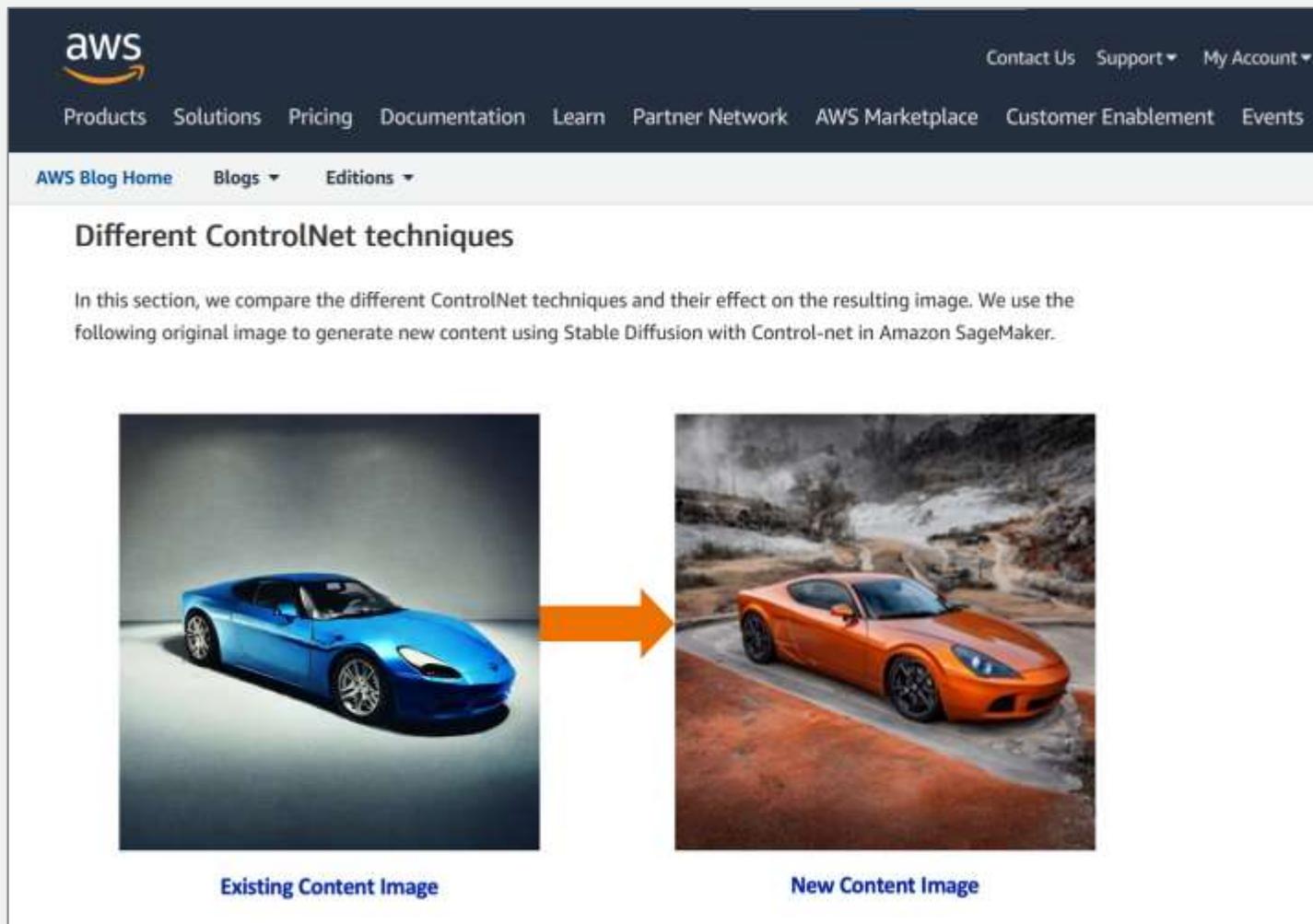
Enable search by an interesting image online (traffic cone) under specific scene (weather-rainy day & wet road)



Tested on Torc Data (Mostly highway scenes)



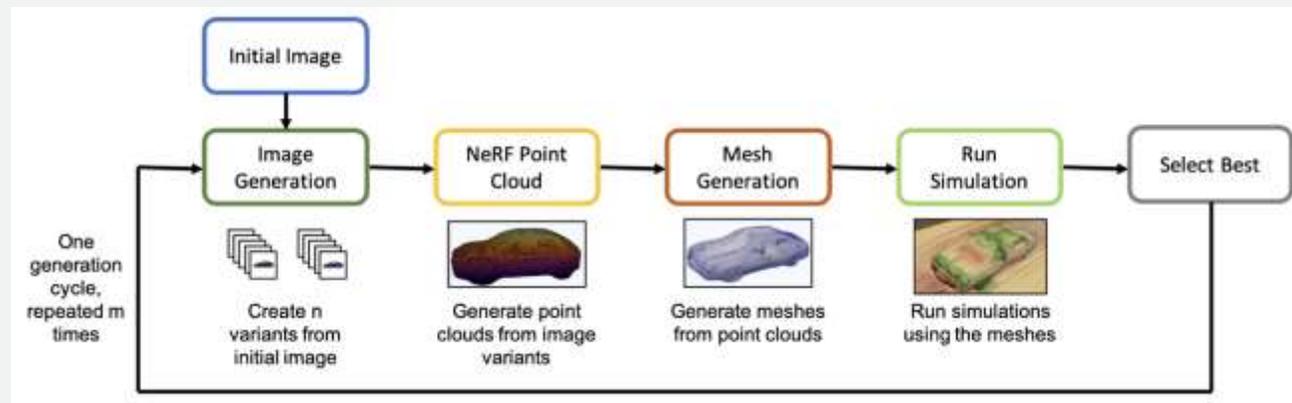
Generative styling



The screenshot shows the AWS blog interface. At the top is the AWS logo and navigation links: Contact Us, Support, My Account, Products, Solutions, Pricing, Documentation, Learn, Partner Network, AWS Marketplace, Customer Enablement, and Events. Below this is a secondary navigation bar with AWS Blog Home, Blogs, and Editions. The main content area features the title "Different ControlNet techniques" and a paragraph: "In this section, we compare the different ControlNet techniques and their effect on the resulting image. We use the following original image to generate new content using Stable Diffusion with Control-net in Amazon SageMaker." Below the text are two images. The first image, labeled "Existing Content Image", shows a blue sports car in a studio setting. An orange arrow points to the second image, labeled "New Content Image", which shows the same sports car in an orange color, parked on a dirt road in a natural, rocky landscape.

<https://aws.amazon.com/blogs/machine-learning/unlocking-creativity-how-generative-ai-and-amazon-sagemaker-help-businesses-produce-ad-creatives-for-marketing-campaigns-with-aws/>

Generative design and simulation



Generative AI is not a magic wand

Deep Generative Model Use Cases: Models & Capability Types

End User Applications | Deep Generative Models | Compute & Storage Infrastructure | Network Infrastructure

The 5 different Deep Generative Models can be segmented by core and non-core capabilities

Current Deep Generative Models & Capabilities

NON-EXHAUSTIVE

Types of Models	Language Generation	Image Generation	Audio Generation	Video Generation	3D Shape Generation
	<i>Deep generative models that generate text output</i>	<i>Deep generative models that generate image output</i>	<i>Deep generative models that generate audio output</i>	<i>Deep generative models that generate video output</i>	<i>Deep generative models that generate 3D shape output</i>
Core Model Capabilities	Retrieve Return response through search of text information	Convert Generate original images using text or image input parameters	Convert Generate original audio using text or image input parameters	Convert Generate original video using text or image input parameters	Convert Generate 3D shapes and models from text or images
	Summarize Compile synthesis of text information				
	Convert Language translation (including code)	Alter Enhance or manipulate existing images by optimizing parameters & produce a new edited image	Alter Accentuate, tone, and modulate voice from existing audio & produce new edited audio	Alter Enhance or manipulate existing videos by optimizing parameters & produce a new edited video	Alter Enhance or manipulate existing 3D shapes by optimizing parameters & produce a new edited 3D shape
	Complete Extend and continues existing text (e.g. autocomplete)				
Non-Core Model Capabilities ¹	Detect Identify anomalies	Detect Identify a parameter within an existing image (e.g. recognition)	Detect Identify a parameter within an existing audio (e.g. recognition)	Detect Identify a parameter within an existing video (e.g. recognition)	
	Analyze Intelligent predictions such as forecasting and segmentation				

Note: 1) Non-core is defined as capabilities deep generative models can indirectly perform but is not best suited for (e.g. other AI/ML technologies are more appropriate)

Source: Expert Interviews, Altman Solon Research & Analysis

Confidential & Proprietary



March 2023

5



Hallucinations (and generative AI jokes)



Explaining a joke

Prompt

Explain this joke:

Joke: Did you see that Google just hired an eloquent whale for their TPU team? It showed them how to communicate between two different pods!

Model Response

Prediction: TPUs are a type of computer chip that Google uses for deep learning. A "pod" is a group of TPUs. A "pod" is also a group of whales. The joke is that the whale is able to communicate between two groups of whales, but the speaker is pretending that the whale is able to communicate between two groups of TPUs.

Improving the quality of generative AI responses

\$

- Prompt Engineering

Prompt: When can I have a meeting?

- Retrieval Augmented Generation (RAG)

Better prompt: When can I have a meeting with Bob, referring to both Bob and my calendars, and looking for open timeslots between 9am and 11am July 15-18, 2023?

- Fine tuning (continue training)

- Build your own FM

\$\$\$\$\$
\$\$\$\$\$

Generative AI maturity

Scaling MLOps... and now Generative AI too



https://www.linkedin.com/posts/eordax_mlops-llmops-fmops-activity-7160874825714937856-xTL0?utm_source=share&utm_medium=member_desktop

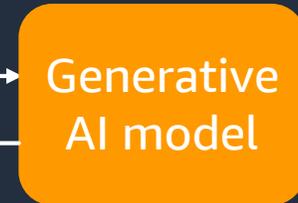
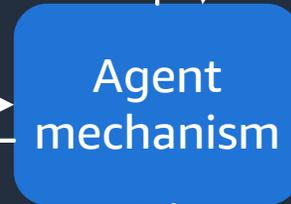


Behind the chatbot: how generative AI works (RAG)

what could cause cam shaft problems?



Query →
← Response



Search →
← Relevant Data

Prompt + Data →

Some possible causes for camshaft related problems could be:

- Worn or damaged camshaft lobes: The camshaft lobes activate the valves by pushing on the valve lifters. Worn or damaged camshaft lobes won't be able to properly activate the valves, causing issues like rough idle, misfires, loss of power, etc.
- Camshaft timing issues: If the camshaft timing is off, the valves won't be activated at the proper time relative to the position of the pistons. This can also cause problems like rough idle, misfires, loss of power, etc. Camshaft timing issues can be caused by a worn camshaft timing chain, faulty camshaft

2007 FCID On Board Diagnostics SECTION 4: Powertrain DTC Charts and Descriptions
Revision: 08/03/2006

Diagnostic Trouble Code (DTC) Charts and Descriptions

Note: Refer to the applicable Workshop Manual section to diagnose the body and chassis DTCs.

P0010 - Intake Camshaft Position Actuator Circuit Open (Bank 1)

Description: The powertrain control module (PCM) monitors the variable camshaft timing (VCT) circuit to the PCM for high and low voltage. The test fails if the voltage exceeds or falls below a calibrated level for a calibrated amount of time.

- Open or short in the VCT circuit
- Open VVTR circuit
- Open or short in the VCT solenoid valve

This DTC is a circuit check. Testing should include the harness and solenoid coil.

Key On Engine Off	Key On Engine Running	Continuous Memory
	GO to Pinpoint Test L5C .	GO to Pinpoint Test L5C .

Camshaft Position Timing - Over-Advanced (Bank 1)

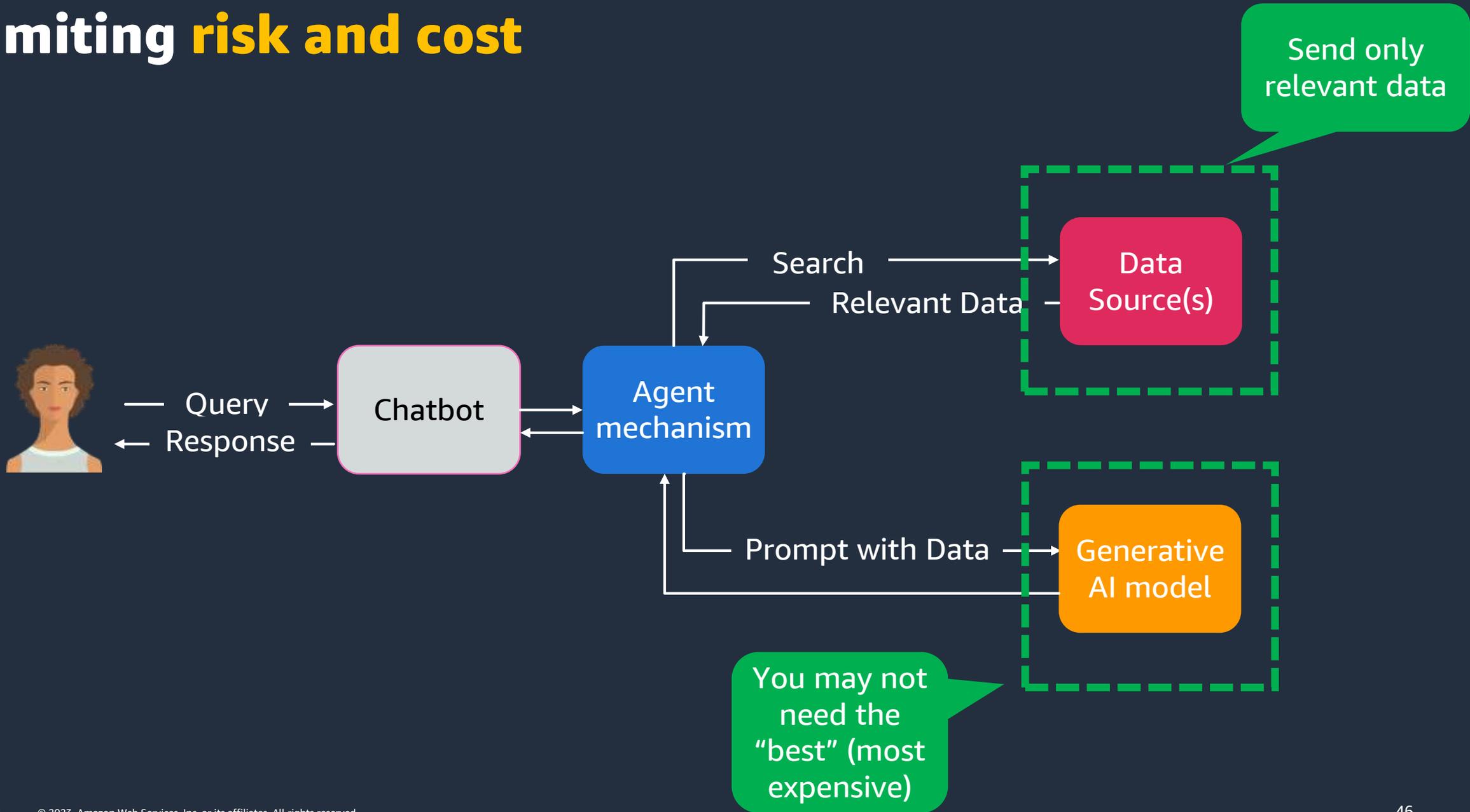
The powertrain control module (PCM) monitors the variable camshaft timing (VCT) position or an over-advanced camshaft timing. The test fails when the camshaft timing exceeds a maximum calibrated value or remains in an advanced position.

- Camshaft timing improperly set
- Continuous oil flow to the VCT piston chamber
- VCT solenoid valve stuck open
- Camshaft advance mechanism binding (VCT unit)

This DTC is a functional check of the VCT unit. Diagnose any base engine concerns related to the engine oil pressure or engine timing. Refer to the Workshop Manual Section 500-00, Engine System.

Application	Key On Engine Off	Key On Engine Running	Continuous Memory
All	—	GO to Pinpoint Test L5C .	GO to Pinpoint Test L5C .

Limiting risk and cost



Why choice and flexibility is critical for scale

what do p0011, p0012, and p0016 fault codes have in common? What could be the root cause? explain in detail and summarize key points using bullets

Based on the document excerpts provided:

- P0011, P0012, and P0016 are all related to the variable camshaft timing (VCT) system.
- They indicate issues with the correlation between the camshaft and crankshaft positions.
- Possible common causes include:
 - Improper timing
 - Issues with the VCT solenoid valve
 - Binding in the VCT advance mechanism
 - Worn timing chain or timing chain tensioner components

To summarize:

- P0011, P0012, and P0016 are all related to the variable camshaft timing (VCT) system.
- They indicate issues with the correlation between the camshaft and crankshaft positions.
- Possible common causes include:
 - Improper timing
 - Issues with the VCT solenoid valve
 - Binding in the VCT advance mechanism
 - Worn timing chain or timing chain tensioner components

The fault codes P0011, P0012, and P0016 have the following in common:

- They are related to issues with the variable camshaft timing (VCT) system.
- P0011 and P0012 specifically refer to intake camshaft position timing being over-advanced or over-retarded on bank 1.
- P0016 refers to a misalignment between the crankshaft position

The P0011, P0012, and P0016 fault codes are all related to issues with variable camshaft timing (VCT).

The root cause of these codes could be related to the VCT system, including:

- Camshaft timing improperly set
- VCT solenoid valve stuck open
- Camshaft advance mechanism binding (VCT unit)

The common factors in these codes relate to the intake camshaft and issues with camshaft timing, which may cause the camshaft timing to be advanced or retarded beyond the calibrated limits.

The diagnostic trouble codes (DTCs) related to the variable camshaft timing (VCT) system include P0011, P0012, and P0016.

The diagnostic trouble codes (DTCs) related to the variable camshaft timing (VCT) system include P0011, P0012, and P0016.

~ \$32/m tokens

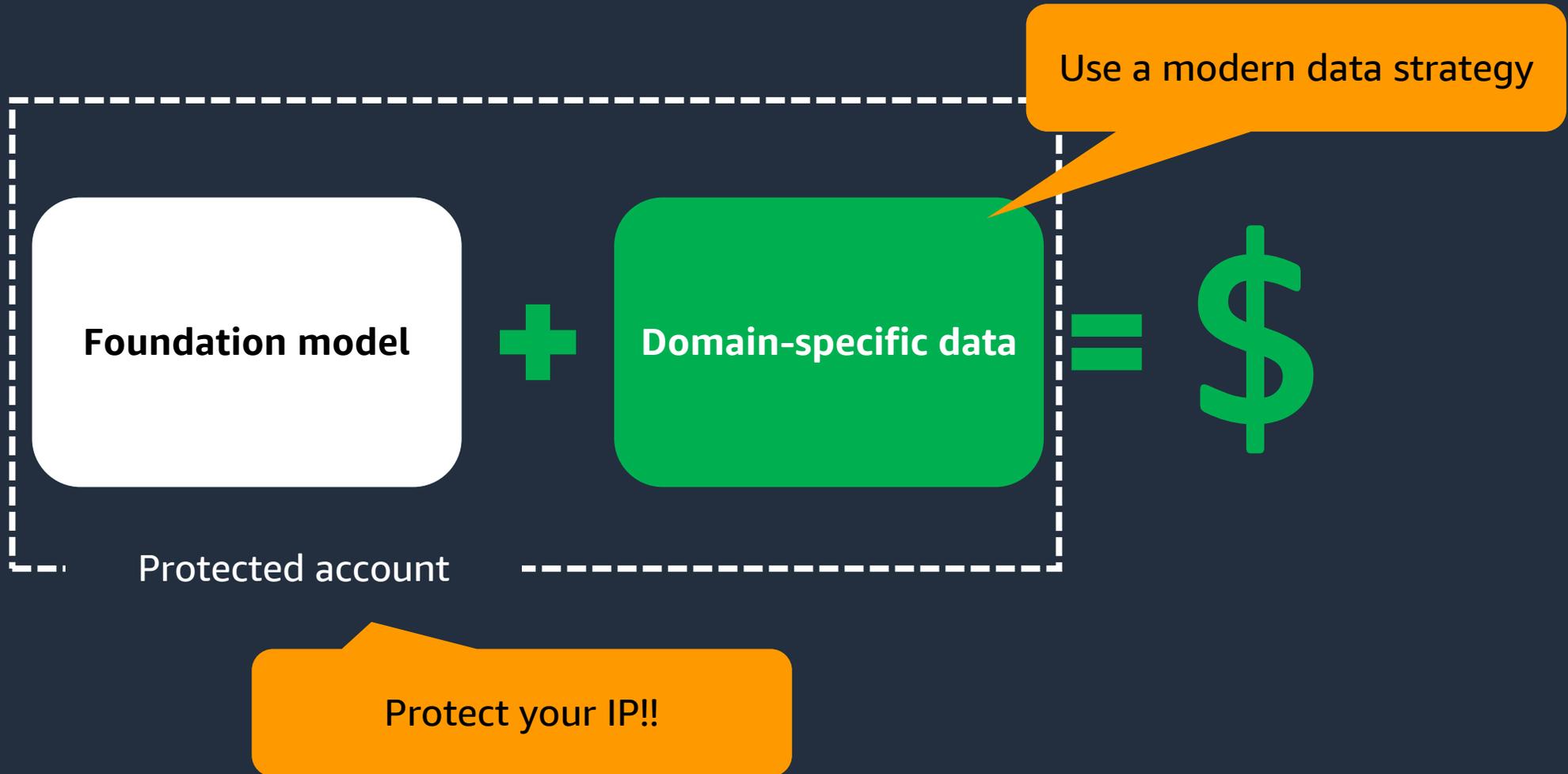
~ \$3.2/m tokens

~ \$3.5/m tokens

If quality of output is equivalent...

If you wanted to roll out a maintenance chat bot to 20,000 technicians...

True value of generative AI is with **leveraging your data**





Thank you!

Learn more:

<https://aws.amazon.com/generative-ai/>

<https://aws.amazon.com/bedrock/>

<https://aws.amazon.com/sagemaker/>

<https://aws.amazon.com/codewhisperer/>

<https://aws.amazon.com/q/>